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CONTENTS.

PAGE.

Editorial 101
The Transforming Central Station of the Buffalo General Electric Company 103
Telegraphing Without Line Wires—III., by William Bissing 110
Meeting of the Special Committee of the Underwriters' National Electrical Association 111
A Simple and General Method of Obtaining the Virtual Value of an Alternating Current or Electromotive Force, by Samuel J. Barnett 113
Convention of the Northwestern Electrical Association 114
Electric Vehicles and Their Relation to Central Stations, by H. M. Maxim. 116
Design of Secondary Circuits in Alternating Plants, by Geo. I. Thayer 118
Utilization of Exhaust Steam, by J. H. Harding 120
Convention Notes 120
Digest of Current Electrical Literature, Compiled by Carl Hering 122
A Novel Overhead Electric Traveling Crane 128
The Commercial Iron Clad Motor 128
A New Internal Combustion Motor 129
A Siemens & Halske Generator of New Design 129
Departments:
Financial Intelligence 130
Special Correspondence 130
General News 133
Legal Notes 134
Personal Notes 134
Trade and Industrial Notes 135
Illustrated Record of Electrical Patents 135

CONVENTION OF THE NORTHWESTERN ELECTRICAL ASSOCIATION.

The regular annual convention of the Northwestern Electrical Association, a report of which may be found on other pages, was held in the usual place at the usual time of year, Milwaukee, Wis., January 18, 19 and 20. This association is made up of the owners and managers and engineers of the central stations of the Northwest, chiefly Wisconsin, most of them small plants as compared with those of the large cities, with the typical features of country central stations, series-arc circuits, single-phase alternating incandescent and 500-volt power systems. Such men are not so much interested in matters of scientific, strictly electrical, or even purely enginering matters as they are in the problems of their own business, such as franchises, the influencing of legislation, competition of gas, etc. To them conventions are of particular value in that they can there compare notes with each other on analogous difficulties of local management or policy that rarely find their way to publication in the technical press, which concerns itself more with the affairs of the larger systems of the great cities. The papers chosen for this meeting, as a rule, happily met this requirement of immediate local application. The attention was, therefore, greater than in any previous convention of the same association, and was particularly reflected by the serious and thoughtful discussion of the problems of meters versus contract rates, the use of exhaust steam for heating and the improvement of alternating service.

Many of the stations represented at the convention are still unconverted to methods of charging based on meter records in place of flat-rate contracts. The convention gave to those already persuaded an opportunity to do evangelistic work with the personal arguments which no amount of published matter can equal. The comparison of station meter records with the total of customers' meters, which was advised, will undoubtedly astound most managers of alternating-current stations if followed. The all-day losses of lightly loaded house-to-house transformers, the line drop, the losses in meter shunts and the effect of friction on the customers' meters at low loads aggregate in such cases a loss between the switchboard and the customers' premises of from 50 to 75 per cent. of the total output, even with no flat-rate or contract loads.

THE CENTRAL STATION OF THE BUFFALO GENERAL ELECTRIC COMPANY.

A central station unique in that its source of power is electrical, making it only a transforming station, although by far the largest and most complex of that type, is that of the Buffalo General Electric Company, a description of which may be found on other pages. Being the first installation to transform power in so many ways and on such a large scale, it will undoubtedly be the scene of much pioneer work and the solution of many problems, the results of which will find wide application in cities similarly situated with regard to large natural powers. The most obvious of these during the station's early operation have been the question of the continuity of supply and the regulation of the voltage, the former having been already discussed in these columns.*

The apparatus of the station may be divided on the score of regulation into two general classes, so far as the effect of the incoming power from Niagara upon the voltage of the output is concerned. Rotary converters deliver a direct-current voltage practically proportional to the alternating-current voltage of the incoming lines and independent of the variations in frequency. Motor generators,

*See THE ELECTRICAL WORLD, January 21, 1899, page 73.

on the other hand, are unaffected by variations in the voltage of the incoming power supplied to them, but are directly affected by the frequency in that their speed is proportional thereto. Further, in this plant the voltage of the exciter circuits is changed by variations in frequency, which in turn acts upon the generators of the alternating-current motor-generator sets, and, if the latter are working upon a steep portion of the magnetization curve, gives to their output a voltage practically proportional to the square of the frequency. Thus, a change of frequency by 1 per cent. causes a change of voltage of the motor-driven generators by 2 per cent.

The Niagara power plant has at present a load of about 20,000 horse-power, large enough and steady enough to give a very steady frequency, but it is laid out on the plan of running independent machines for loads calling for different switchboard voltages, so that at the present time the Buffalo load is necessarily isolated from the Niagara Falls local load, and carried on one or two independent machines. The fluctuations of the Buffalo load, caused by the street railway lines supplied, are a little too rapid to be followed by the gates of 5000-hp turbines with sufficient promptness for incandescent lighting, especially when, as pointed out above, the rise and fall of voltage at the lamps is made double the percentage variation of the frequency. The best means known for steadying such a system is the storage battery, a means the Buffalo General Electric Company is already preparing for service, but unfortunately on account of the reversibility of rotary converters, motor generators, etc., it will be necessary to steady not only the direct-current circuit to which the battery is attached but to a certain extent the extensive alternating-current system linked therewith, requiring a very large battery.

Obviously the motor generator sets supplying the arc lights are unaffected by the pressure of the incoming power supplied to them as well as by the frequency, provided the changes in the latter are not sudden. Automatic regulators of arc dynamos adjust for the same current over a range of speed far greater than any variations of frequent occurrence in installations of this kind. Another type of transforming machine is peculiar in that the voltage of its output is proportional to both the frequency and the voltage of the incoming power. This is the frequency changer of the type in which a multiphase secondary is mechanically rotated and acted upon by the rotating field of a multiphase primary. Such machines are used to a certain extent for transforming from one frequency of alternating currents to another, the Kings County Electric Light & Power Company, of Brooklyn, having some in service to change from the 25 cycles of its high-tension generating plant to the 60 cycles needed for an existing alternating-current distributing system. The voltage on the lines to which power is delivered from such a machine is obviously proportional to the product of two factors, one the intensity of the field across the air gap of the transforming machine, which is in turn proportional to the voltage of the incoming power; the other, the sum of the speeds of the secondary conductors and the primary rotating field, which is proportional to the frequency of the incoming power. When the voltage and frequency of the incoming power both vary together, which is commonly the case, the voltage regulation of the output is seriously affected. The Buffalo General Electric Company uses for the same purpose motor generators, fearing the influence of the line drop on the lamp regulation, although the magnified influence of the frequency variations described above may give even more trouble with the type of machine adopted. Some simple means of automatically regulating the voltage of the various types of transforming apparatus now coming into use in such a way as to make it independent of small variations in the frequency and pressure of the incoming power will probably be found to be much needed in plants of this kind.

THE AUTOMOBILE AS A DAY LOAD FOR CENTRAL STATIONS.

The central station managers of this country have lately learned that the use of the storage battery as a means of smoothing out the daily load curve is a paying investment, in spite of the losses in the battery, which range from 20 to 40 per cent. of the power stored, and in spite of its cost, depreciation, space occupied, attendance, and other disadvantages. The installation of storage batteries by customers, the latter bearing all costs and losses and undertaking the attendance, the central-station load curve being leveled, not by cutting off the peaks and filling up the hollows to meet, but by filling up the hollows to the full height of the peaks, must seem to the central station manager and owner too good a dream to be true; yet it appears that such a load can be developed during the next few years if the central stations are careful to cultivate the load for themselves rather than allow it to be taken by isolated plants. The paper by Mr. H. M. Maxim, read before the convention of the Northwestern Electrical Association, on "Electric Vehicles and Their Relations to Central Stations," an abstract of which appears on other pages, points out some of the advantages of such a load. Its magnitude in the present state of the electric vehicle art is, of course, insignificant, but with the growing use of the electric automobile that is confidently expected the charging of the accumulators therefor will absorb an enormous amount of power. From figures given by Mr. Maxim, the average electrical delivery wagon will consume from 10 to 15 kw hours per day, pleasure wagons less and heavier vehicles more. If the electric automobile replaces no more than one-quarter of the horses used in the large cities, the consumption of energy in charging the batteries will amount to a constant load of many thousands of horse-power.

This load is not one that must be fed at a certain time. With removable battery trays the charging can be done at any time of the day or night when found convenient, and will be done when the current can be obtained most cheaply, which, if central-station current is used, is the time of the deepest hollow of the load curve. The charging of the batteries of pleasure and other vehicles, but one or two of which belong to the same owner, will naturally be effected from central-station mains, since such vehicles will be kept in private structures or existing horse stables, without independent means of generating power. In such cases the simple insertion of a two-rate meter will largely prevent the use of power for charging purposes at the time of the station's peak. The supply of larger consumers, such as cab systems, the delivery wagons of express companies and large department stores, etc., will have to be more carefully cultivated. The amount of power used will naturally incline owners to the installation of isolated plants, the cost of power from which will be low, owing to the possible uniformity of the load curve. The central station, however, has an advantage here which it has not over the isolated plant for office building or other service, in that the load curve of a battery-charging station may be made to fluctuate in such a way as to complement the fluctuating load curve of lighting service, the battery load thus causing no increase in the station's fixed charges. For this reason the central station may, if it is allowed to control the time of day when the batteries are charged, give a very low rate for the power used, making the most of its advantage over isolated plants of centralized generation on a large scale.

To keep this load in its own hands it will be necessary for the central station to cater to it, perhaps arranging for charging stands or stables in the neighborhood of the power stations, in order to minimize copper losses, supplying these with the several voltages needed for the economical charging of storage batteries at constant current, and in other ways forestalling the general erection of special charging plants, which are sure to compete for a share of this profitable load when the business becomes a large one.

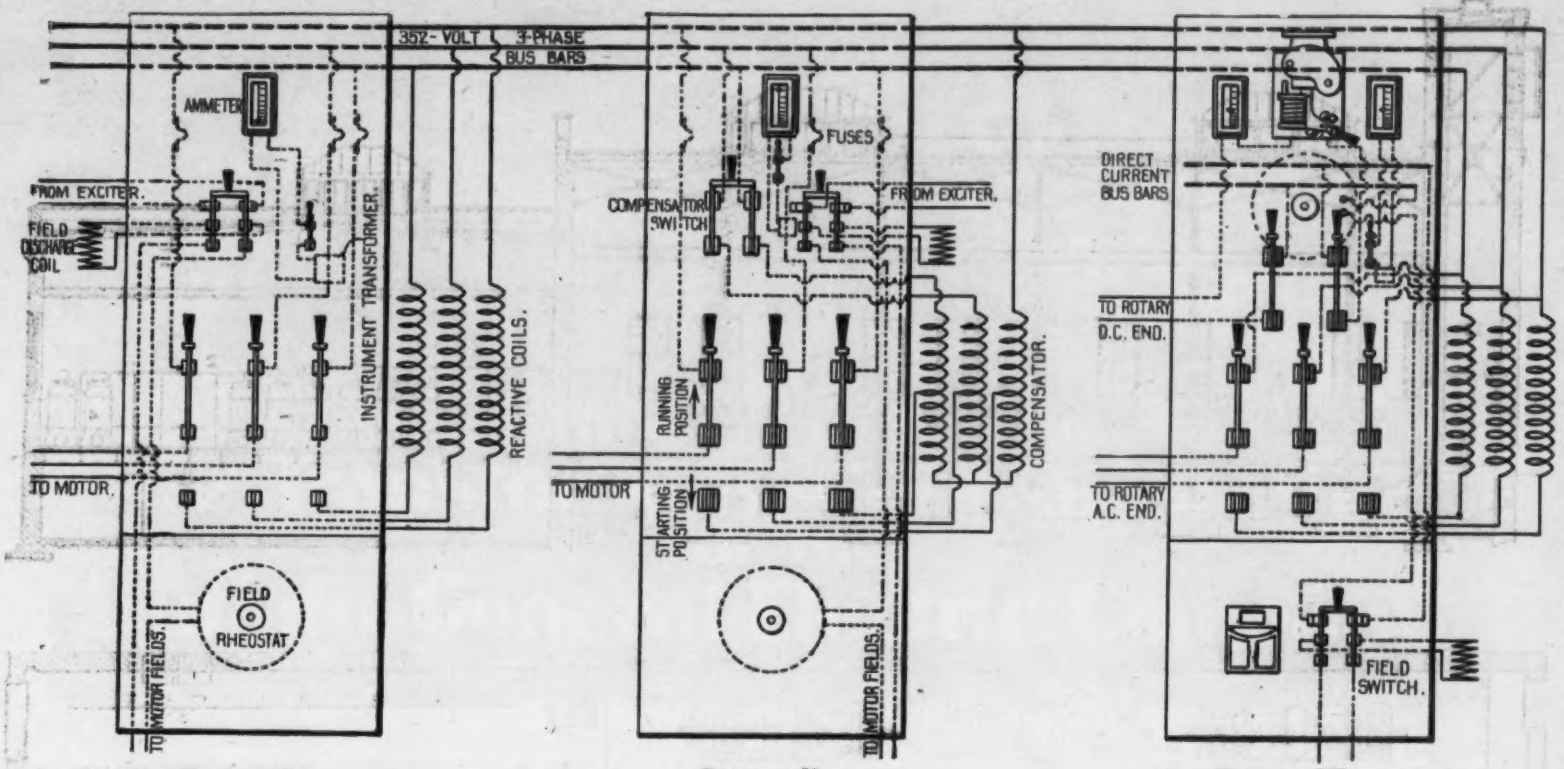
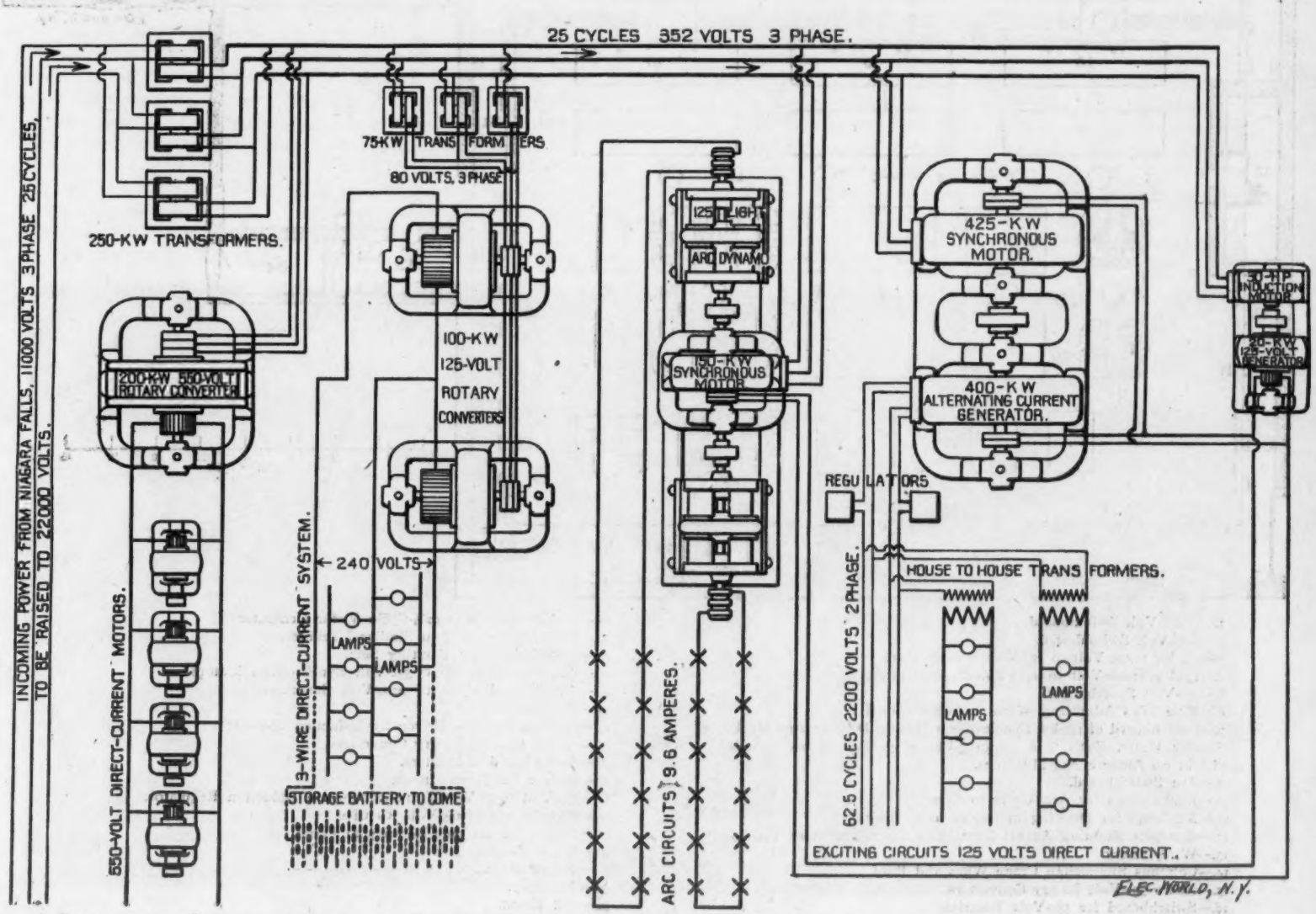
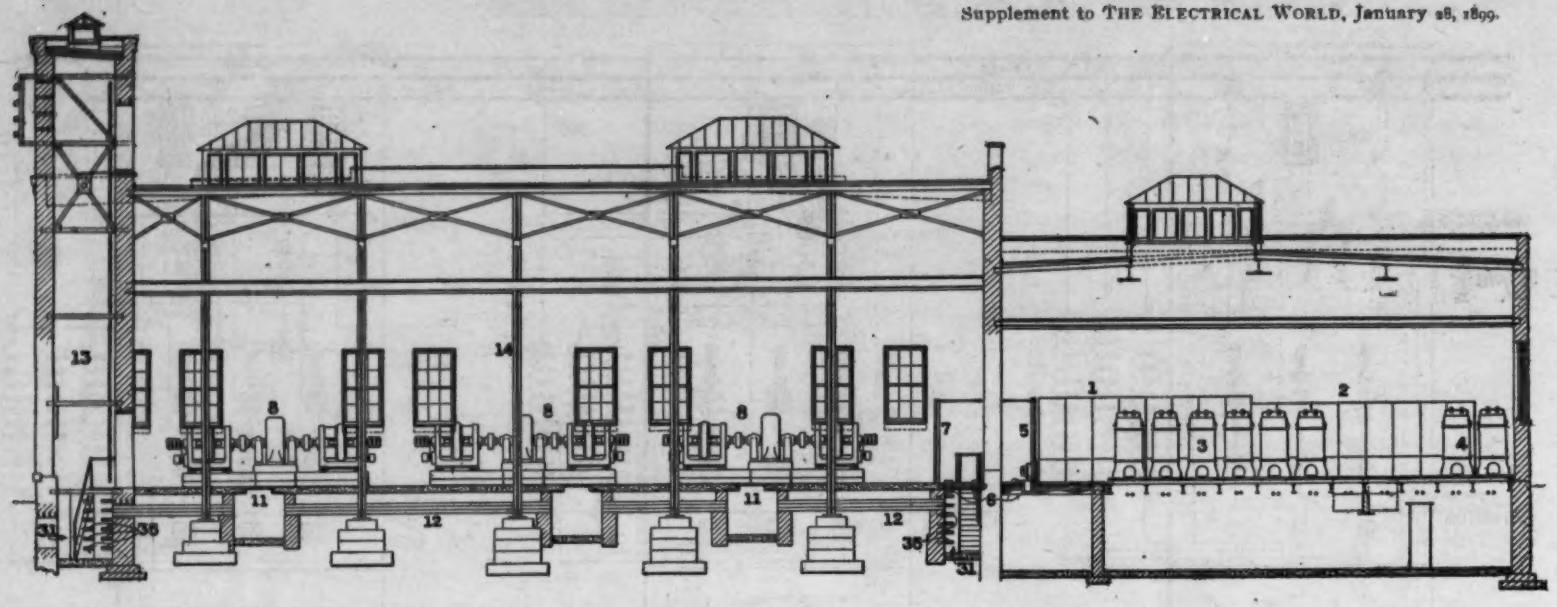


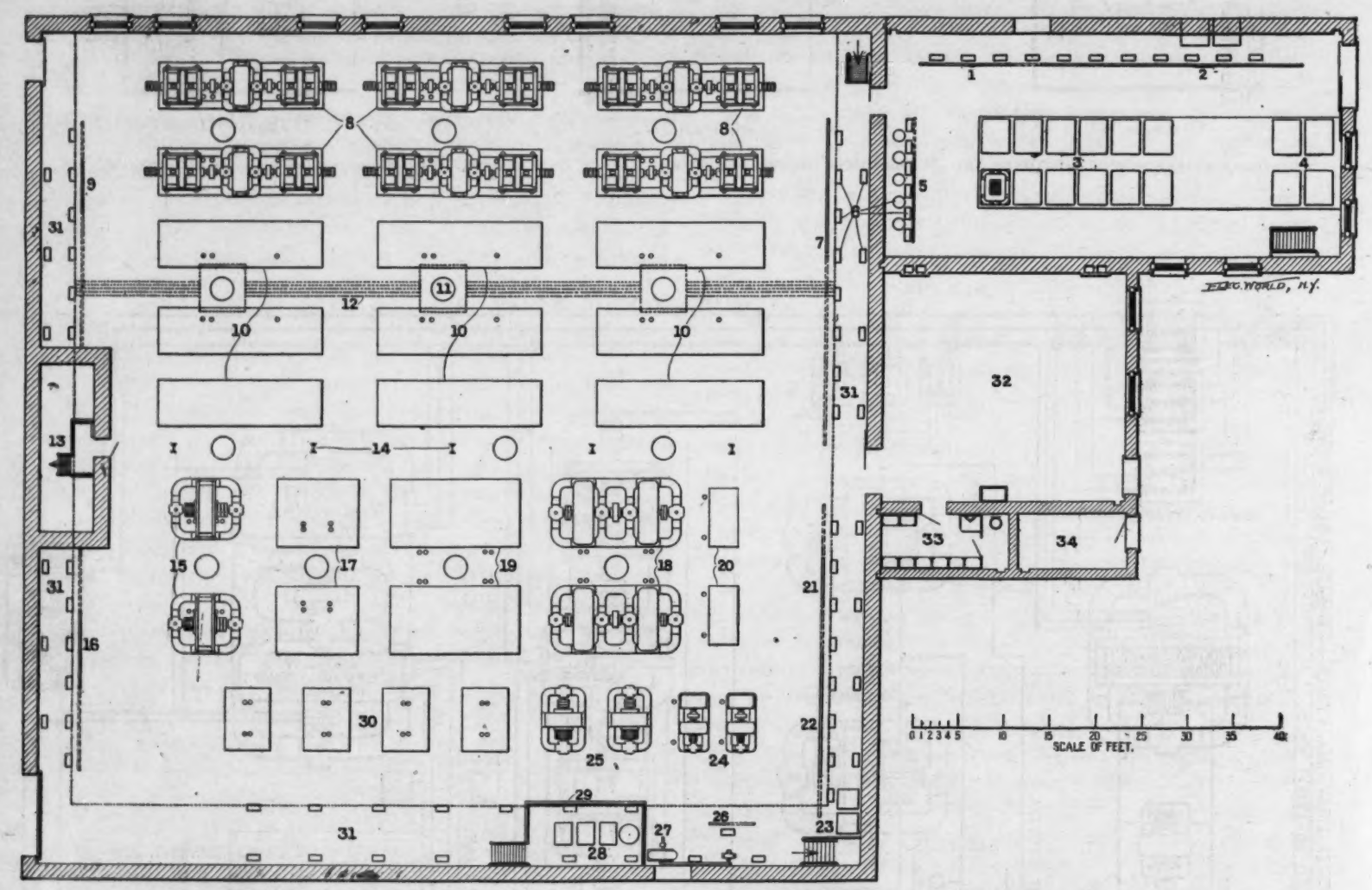
DIAGRAM I. DIAGRAM II. DIAGRAM III.

THE CONNECTIONS OF THE SWITCHES AND INSTRUMENTS OF THE 150-KW AND 425-KW SYNCHRONOUS MOTORS AND 550-VOLT ROTARY CONVERTERS.



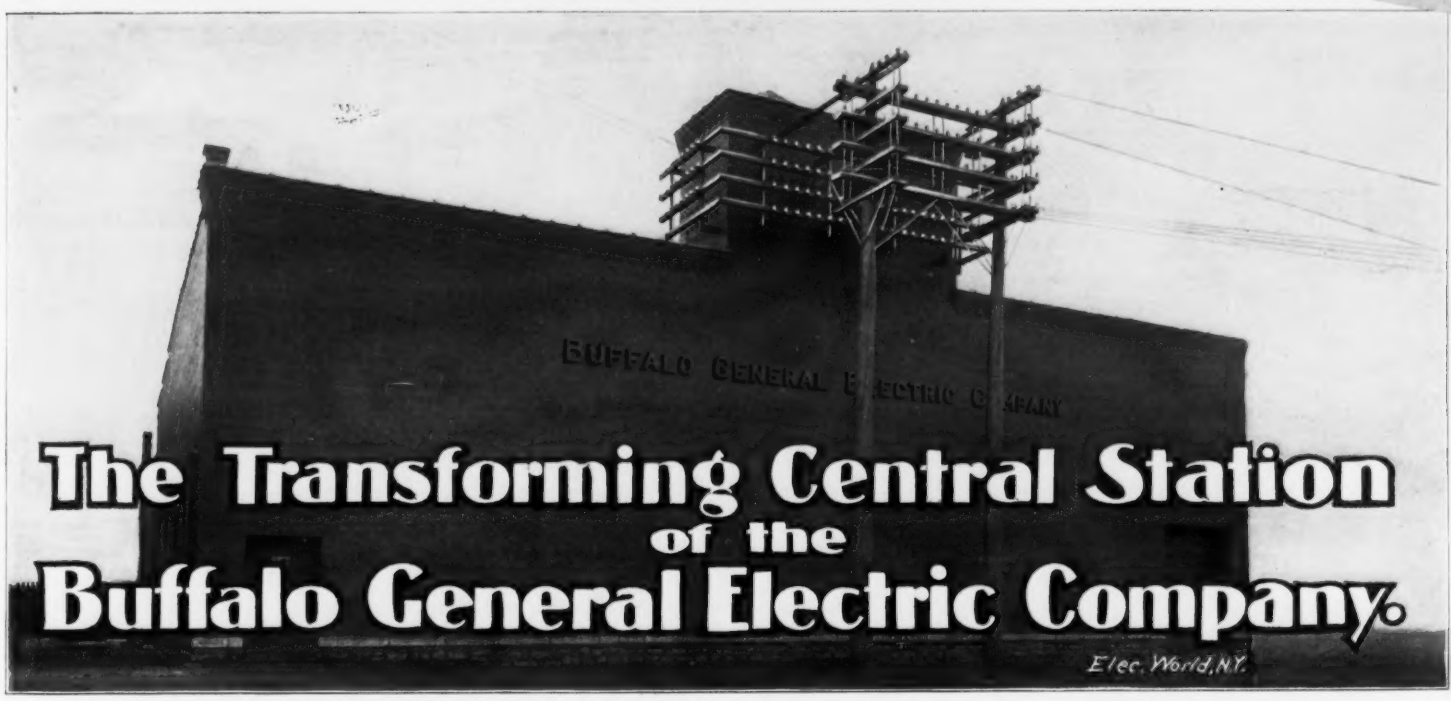
A DIAGRAMMATIC REPRESENTATION OF THE TRANSFORMATIONS OF NIAGARA POWER EFFECTED BY THE BUFFALO GENERAL ELECTRIC COMPANY.





1.—11,000-Volt Switchboard.
2.—2200-Volt Switchboard.
3.—250-kw 11,000-Volt to 352-Volt Transformers.
4.—250-kw 11,000-Volt to 2200-Volt Transformers.
5.—352-Volt Switchboard.
6.—Flue Tiles Admitting Wires to Wire Tunnel.
7.—Switchboard of 150-kw Synchronous Motors Driving Arc Machines.
8.—Arc Units, Each One 200-hp 3-Phase 352-Volt Motor Coupled to Two 125-Light 9.6 Ampere Arc Machines.
9.—Arc Switchboard.
10.—Foundations for Arc Units to Come.
11.—Manholes for Drawing in Cables to Conduits.
12.—Conduits Running Across from Wire Tunnel to Wire Tunnel.
13.—Wire Tower.
14.—Columns Supporting Crane Ways and Roof.
15.—200-kw 550-Volt Rotary Converters.
16.—Switchboard for 550-Volt Rotaries.
17.—Stands for Two 400-kw 550-Volt Rotaries to Come.
18.—400-kw 25-Cycle to 62½-Cycle Motor Generators.
19.—Foundations for Two Similar Machines.
20.—Foundations for Exciting Sets.
21.—Switchboard of 25-kw 352-Volt Synchronous Motors.
22.—Switchboard of 400-kw 2200-Volt Generators.
23.—Regulators.
24.—125-Volt Exciters Driven by Induction Motors.
25.—100-kw 125-Volt Rotary Converters.
26.—Switchboard of Exciters.
27.—Blower for Transformers.
28.—352-Volt to 80-Volt Transformers and Induction Regulator.
29.—Switchboard of 125-Volt Rotaries.
30.—Stands for 125-Volt Rotaries to Come.
31.—Wire Tunnel.
32.—Repair Room.
33.—Lavatory.
34.—Oil Room.
35.—Shelves in Wire Tunnel.

PLAN AND ELEVATION OF THE TRANSFORMING CENTRAL STATION OF THE BUFFALO GENERAL ELECTRIC COMPANY, INCLUDING SUBSTATION NO. 3 OF THE CATARACT POWER & CONDUIT COMPANY. FOR DESCRIPTION SEE PAGE 103 ET SEQ.



The Transforming Central Station of the Buffalo General Electric Company.

In the city of Buffalo, beside the dismantled ruins of the Wilkeson Street plant, the first central station to use alternating-current apparatus in this country, there has been erected by the Buffalo General Electric Company a remarkable installation, embodying the most recent developments of alternating-current work. This is an alternating-current transforming station, a substation of the Niagara system, and at the same time a central station of no mean size, an apparent paradox, but one made necessary for the adaptation of Niagara power for the various services given by the company.

The Buffalo General Electric Company is a consolidation of various electric lighting corporations, and controls the entire electric lighting and power business in the city of Buffalo. Previous to the starting of this station last November, the load was entirely carried by two stations of the type now generally found in large cities where the improvements of the last few years have been held back in anticipation of some revolutionary change. These contained the usual variety of engines, belted dynamos of many makes, sizes and styles, supplying series-arc, alternating-incandescent, 500-volt power and three-wire lighting lines.

The new station will supply the same loads, giving the same four kinds of current, but all the power will be derived from the Niagara Falls power plant over the Cataract Power & Conduit Company's lines, instead of from steam boilers and engines. The layout of the station is thus an entirely different problem from that of the ordinary central station, and resembles more that of a transformer substation on a greatly magnified scale. The problems involved are many of them original in this installation, and their solutions will be interesting to electrical engineers, since many installations of this kind may be expected as soon as distant powers come to be more generally utilized for carrying central-station loads.

THE BUILDING.

The structure, a view of which appears at the head of this page, itself is only one story in height, about 90 by 90 feet, giving a floor area of about 8000 square feet, which is laid out for transforming apparatus with a capacity of 10,000 horse-power, the apparatus for 5400 horse-power of which has already been installed. A plan and elevation of the building are given on the accompanying supplemental sheet. The construction is fireproof throughout, with a cement floor laid on double brick arches on steel I-beams, brick walls, cast-iron lintels, and a roof supported on steel trusses. The

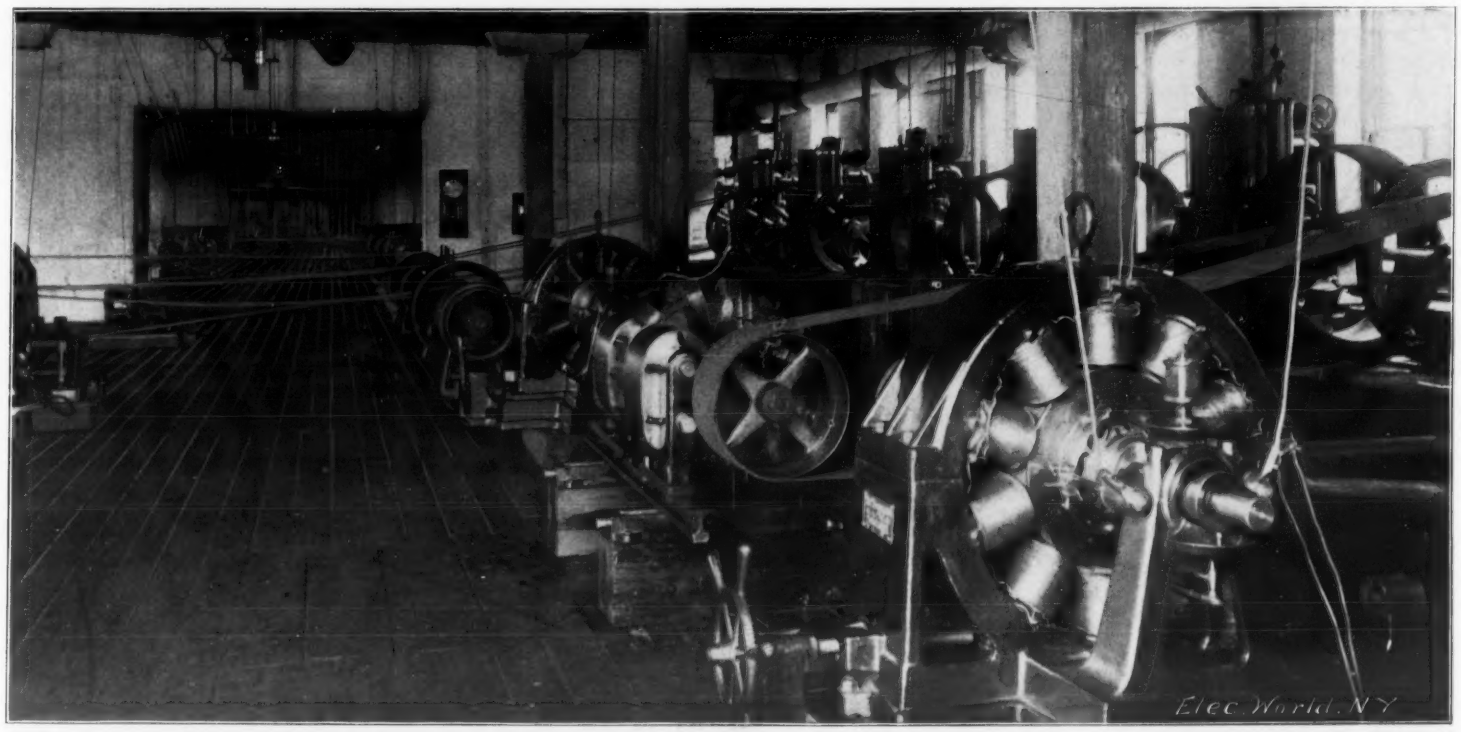
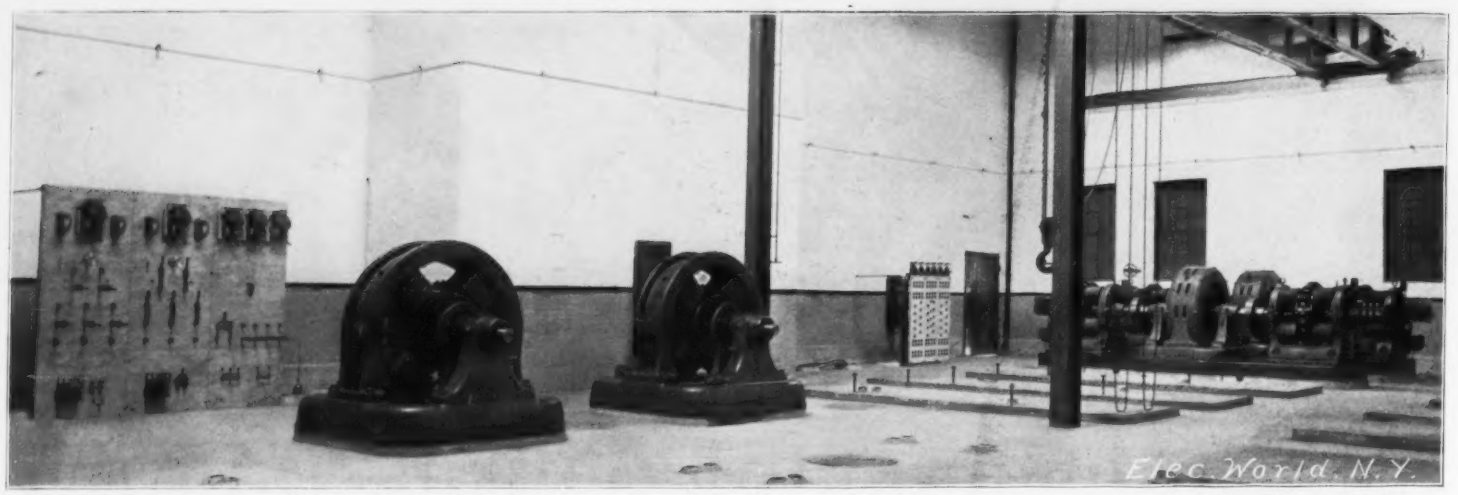


FIG. 2.—THE INTERIOR OF THE WILKESON STREET PLANT, FROM A PHOTOGRAPH TAKEN IN 1887, SHOWING THE FIRST ALTERNATING-CURRE DYNAMOS IN CENTRAL-STATION USE.



The 550 Volt Switchboard. The 550-Volt Rotary Converters. The Arc Switchboard. Arc Units.

FIG. 3.—THESE TWO ILLUSTRATIONS WERE TAKEN FROM THE SAME POINT OF VIEW AND

building is divided into two bays by a central row of columns, each bay roofed with an unusually flat A-truss and splendidly lighted by a large monitor at the ridge. The panes of these monitors may be opened or closed by arms geared down to handles on the floor below. The roof proper consists of book tiling laid in Portland cement and resting on inverted T-irons. Over this is spread a layer of boiling asphalt, which in turn is covered with tarred paper, another layer of asphalt and a pitch and gravel surface, making altogether a most perfect protection not only against leakage of water, but against loss of heat and therefore against sweating. The windows are fitted with fireproof shutters on the outside, all of which may be simultaneously operated from the interior by means of a windlass. The interior is heated electrically by the machine losses, and lighted by a row of incandescent lights run around the walls, as the illustrations show. Each bay is spanned by a 10-ton hand-crane built by Maris Brothers, of Philadelphia.

Naturally in a transforming station the number of wires is about double that of a generating station for the same service, and careful attention must be given to the wire ways. This station is fitted with a wire tunnel or subway 4 feet wide and 6 feet high, running around three of its four sides below the floor level. The supports for the wires—instead of being brackets over which the wires loop, squeezing the insulation and tending in time to crack it at the sharp bends over the supports—are flat shelves of ⅛-inch steel plate let into brickwork, and supported at frequent intervals by angle irons also let in between the bricks. This tunnel connects the wire tower, from which the overhead distribution starts out at one end of the building, with the various motor and dynamo switchboards, which are grouped around the three sides of the main room, and also opens out into the basement of the transforming station of the Cataract Power & Conduit Company, from which all power is derived (see supplement). To reach the machines themselves there are laid between the two parallel branches of the tunnel, running across opposite ends of the building, a number of conduits of vitrified duct. The machines are laid out as a general rule in rows, separated by aisles, and these conduits, with from 18 to 24 ducts each, run down each alternate aisle, with manholes between each pair of machines in which the cables can be branched off and brought up inside the machine foundations. Rubber-covered cables for the low-tension and lead-covered for the high-tension services are laid on the shelves of the subways and drawn into the conduits. Back of the switchboards are openings framed in flue-tiles through the floor into the tunnel, the shelves being discontinued for a few inches below each opening to allow the cables to be carried up.

The neat arrangement of the wooden cross-arms, running around three sides of the wire tower, on steel angle and channel section frames, and carrying porcelain break knobs, is clearly shown in the view of the exterior.

THE ARC LIGHTING SERVICE.

One of the two main bays is devoted entirely to the power-transforming apparatus for the series-arc circuits. All power comes into the station in the form of 3-phase, 25-cycle, alternating-current at 352 volts, this pressure being adopted as it is suitable for the direct feeding of 550-volt rotaries and is as satisfactory for motor work as any other. The power enters the station from the adjoining substation of the Cataract Power & Conduit Company* over cables aggregating 5,000,000 circular mils per leg.

*See THE ELECTRICAL WORLD Jan. 21, 1899, pages 76 et seq.

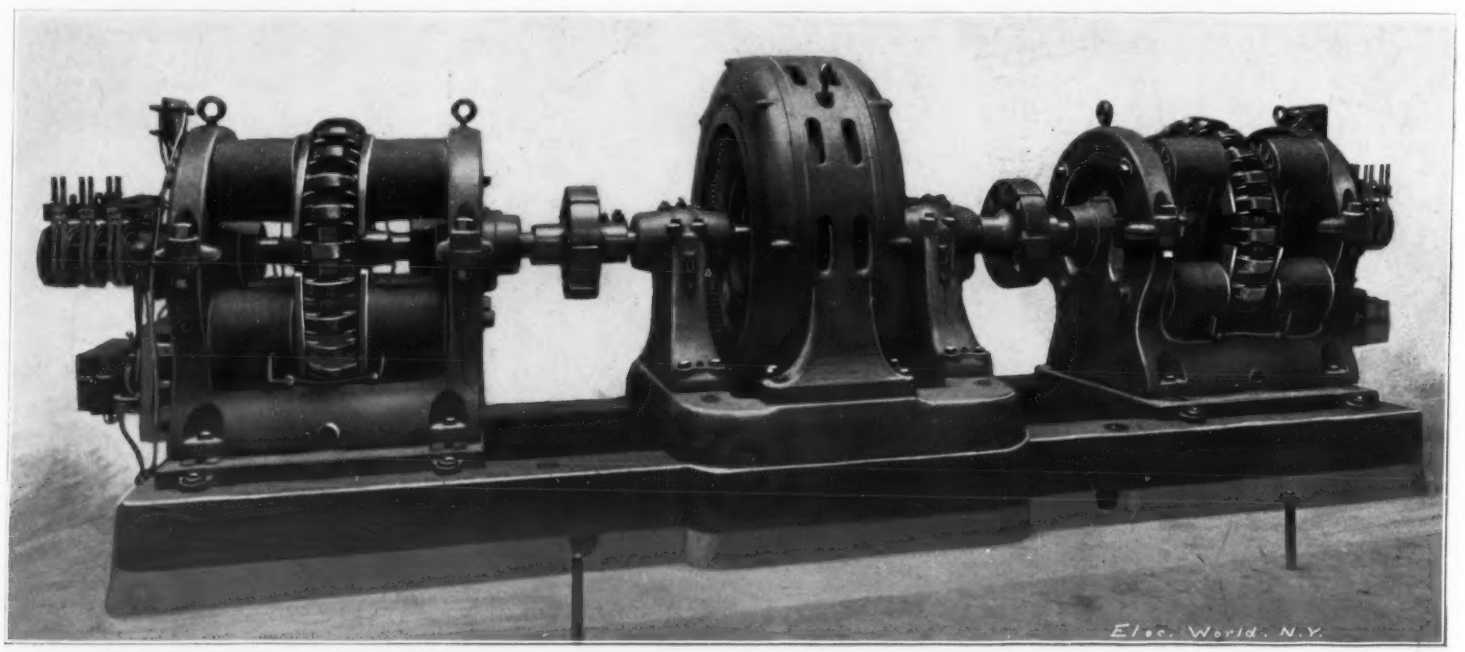
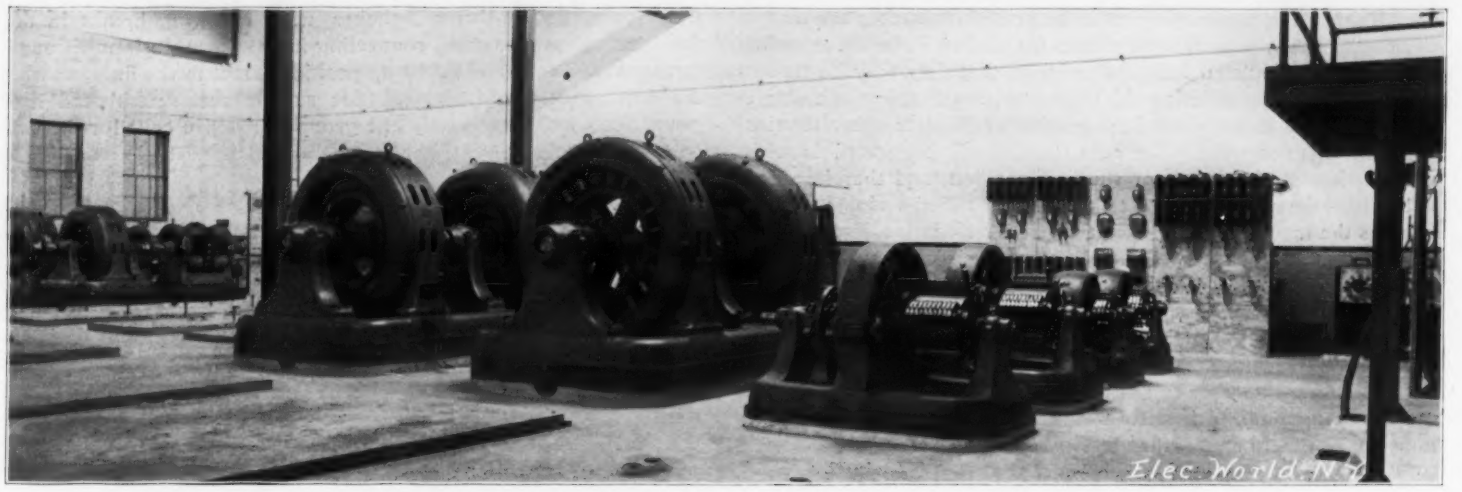


FIG. 4.—ONE OF THE ARC UNITS. A 200-HP SYNCHRONOUS MOTOR COUPLED TO TWO 125-LIGHT ARC DYNAMOS.



Arc Units. Altern ting Motor Generators. 125-Volt Rotaries. Exciters. Transformer Gallery.

COMBINED MAKE A GENERAL VIEW OF THE INTERIOR OF THE STATION.—FIG. 5.

The arc units, one of which is shown in Fig. 4, consist of synchronous motors with rotating fields, each coupled to two Brush arc-light machines. There are stands for fifteen such sets, as the plan shows, of which six are already in place. The motors are six-polar, and therefore, with 25 cycles, make 500 r. p. m. They are rated at 200 horse-power each. The external stationary armature is wound for 352 volts, with a three-phase series winding Y-connected and distributed in three slots per pole per phase. The rotating field is supplied with exciting current at 110 volts through carbon brushes bearing on cast-iron collector rings. The machines are mounted on wooden bases raised on brick foundations about 3 inches above the floor, and the motors are insulated from the arc dynamos by flexible couplings, consisting of the ordinary cylindrical rubber cushions compressed between arms of the driving and driven spiders.

The arc dynamos are single-circuit machines, giving 9.6 amperes, with a capacity of 125 lights each. They are of the latest type developed by the Brush Company, and are fitted with the new oil regulator.* Each machine is also fitted with a substantial ironclad ammeter mounted immediately upon it.

At one end of the row of machines is the motor-controlling board, shown in Fig. 6, and at the other end the arc-light plug switchboard, shown in Fig. 7. The former is fitted with one panel for each motor, the face of the panel containing at the top an edgewise Thomson inclined-coil alternating-current ammeter, and below this a double-pole switch, fitted with carbon following breaks, and also with contacts into which the blades come before they leave the supply clips and which shunt the magnet winding with a non-inductive resistance, thus taking up all inductive strain. Below these are three single-pole double-throw knife switches, with following spring breaks, one for each phase of the motor supply circuit. When thrown downward they connect the motor in circuit through three reactive coils, and thrown upward, connect the motor windings straight across the three main buses. These connections are shown in switchboard diagram No. 1, on the supplemental sheet. The up and down throw-over arrangement is preferred instead of a short-circuiting switch around the reactive coils, since it makes the one switch serve the purpose of two, and it systematizes the starting arrangements of the various machines throughout the station, which, as a rule, are arranged with switches to be thrown downward for starting and upward for the proper running connections. Below the main switches is the regulating rheostat of the motor field.

The motors are started by throwing them across the mains with the reactive coils in circuit, sufficient torque for overcoming the frictional resistance being given by the hysteresial lag of the traveling field crossing the laminated pole faces. This brings them up to synchronism when current is turned into the fields, the motors run-

*For a complete description of this regulator, see THE ELECTRICAL WORLD Jan. 7, 1899, page 29.

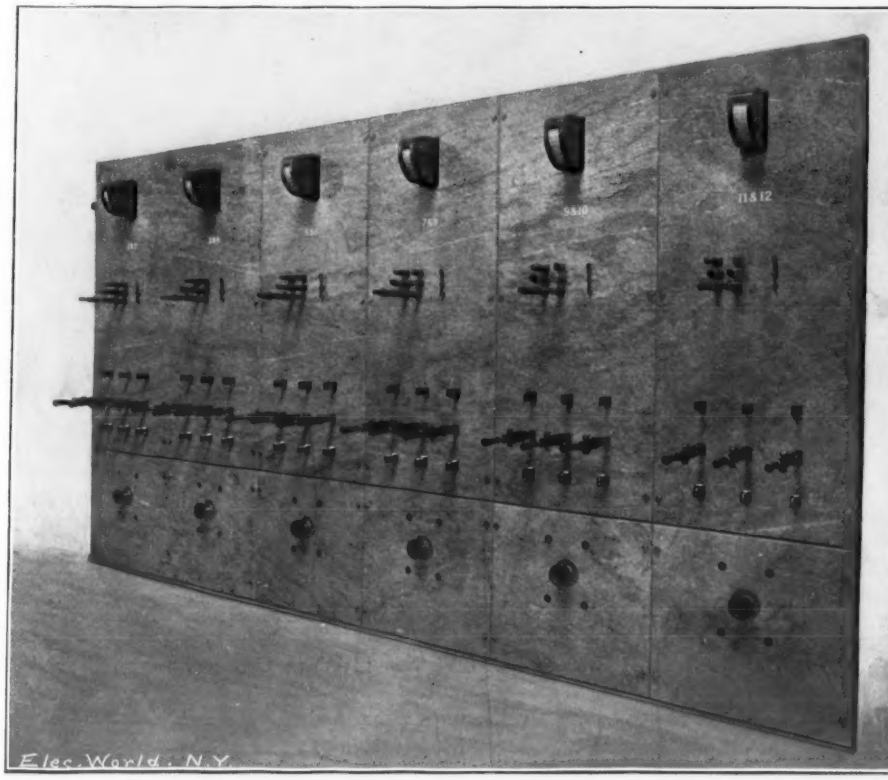


FIG. 6.—THE MOTOR SWITCHBOARD OF THE ARC UNITS.

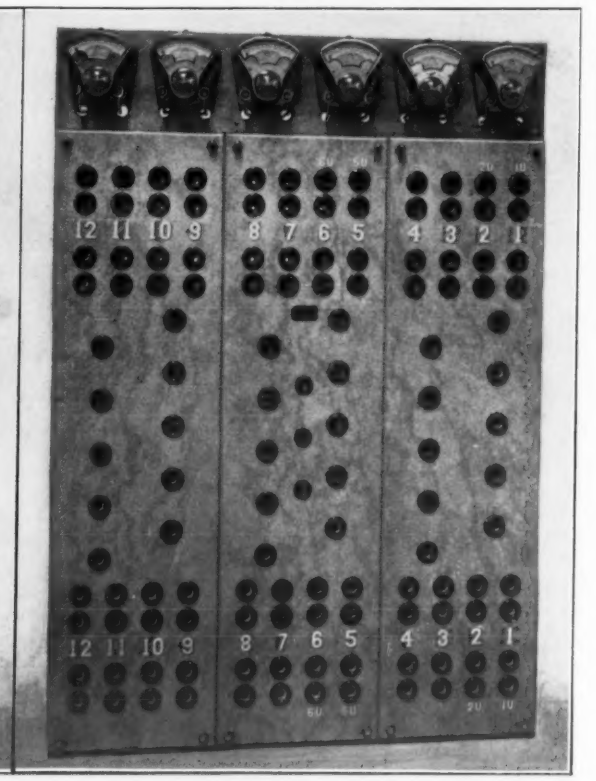


FIG. 7.—THE ARC SWITCHBOARD.

ning light in series with the reactance until the switches are thrown up, connecting them straight across the mains. The three switch blades are manipulated independently, so that they may be thrown over one at a time, allowing the motor to keep running as a single-phase machine across two of the bus-bars, while the other terminal is being changed over. The ammeter is only connected in when the switches are in the up or running position, and therefore does not get the heavy overload starting current nor the violent oscillations as the machine approaches synchronism. It is also fitted with a small switch by which its derived current circuit may be opened. The fuses, which are of aluminum, mounted on the back of the board, are also not in circuit when the machines are on the reactive coils.

The arc machines are connected up with the regulation arc switchboard at the other end of the bay, and from here the lines pass out to the manhole in front of the old Court Street station in two, four, six and eight conductor arc-light cables.

THE POWER-SERVICE CONVERTERS.

The other bay is devoted to rotaries for the 550-volt and the 240-volt, three-wire systems, and motor generators for excitation and for obtaining a higher frequency of alternating currents for the incandescent systems. For the 550-volt service there are now installed two four-pole, 200-kw rotary converters, one of which is illustrated in Fig. 9, running, of course, with 25 cycles, at 750 r. p. m. These machines have very wide pole shoes, a short gap, and, consequently, a small waste of current in field excitation and a high armature reaction, which is permissible in this type of machine. They are fitted with quite a heavy series field winding, designed to give a considerable variation in the wattless component of the incoming currents with varying load, and thereby, in connection with the self-induction of the supply circuits, to over-compound the direct-current end.

They are also designed for starting from the alternating-current end by the hysteresial drag, and—as in this operation the fields are subject to an alternating flux—the shunt of the series field winding is fitted with a switch to prevent its acting as a short circuit at this time. The shunt field is also fitted with a multipolar switch on the frame of the machine, whereby it may be split up into its four separate coils, each getting only one-quarter of the extremely high voltage which would be generated across the field terminals were they all connected in series under the starting conditions.

The rotaries are fitted with a switchboard, illustrated in Fig. 8, having a panel for each of them and one for the three outgoing feeders. Each rotary panel, beside the regular circuit breaker, field switch, field rheostat, integrating wattmeter and main switches customary with direct-current generators, has two edgewise ammeters, one for the d. c. and one for one phase of the a. c. side, and three single-pole, double-throw switches with following breaks in the three incoming a. c. leads, connecting in the down position through three reactive coils and in the up position direct to the lines, as with the motors described above. (See supplement, switchboard diagram No. 3.) There is only one group of reactive coils for the two

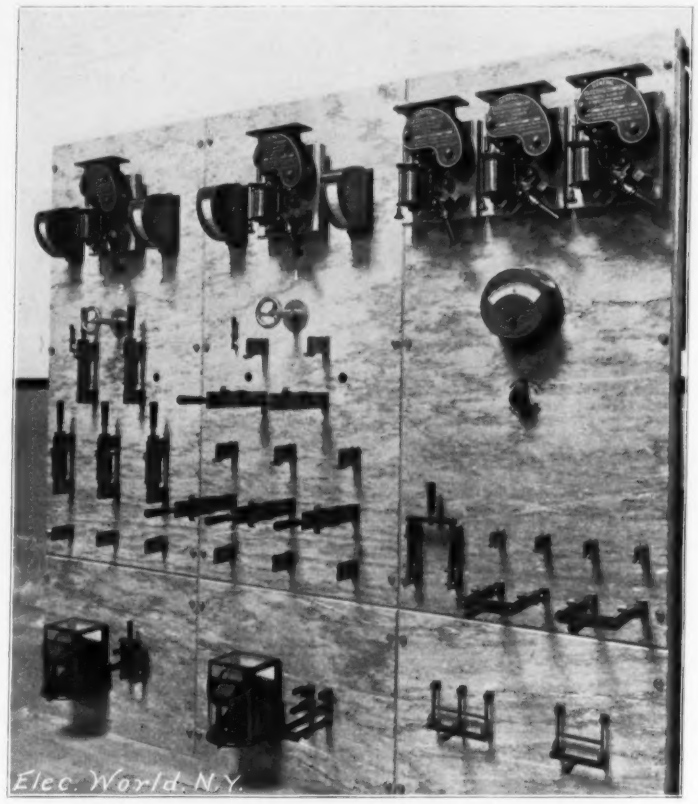


Fig. 8.—The 550-Volt Switchboard.

machines, and there is no equalizer, although the two are intended to be worked in parallel. The feeder panel contains the feeder circuit breakers, switches, fuses and a ground detector, as well as two switches for the interrupter. This is a device used on all the rotaries to give the shafts an oscillating axial motion to distribute the wear of the brushes uniformly on the commutators. It consists simply of a small magnet, attracting the end of the shaft, the magnets of all the machines being intermittently supplied with direct current from an interrupter run by a small induction motor.

Fig. 9.—One of the 550-Volt Converters.

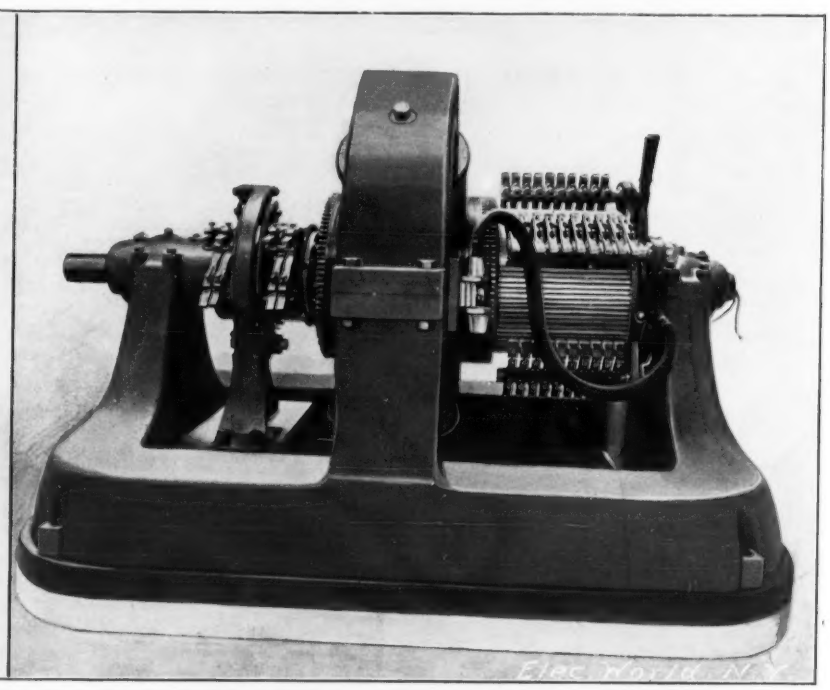


Fig. 10.—One of the 125-Volt Converters.

THE 125-VOLT CONVERTERS.

Two 100-kw, 125-volt rotaries, shown in Fig. 10, are also in service to supply the three-wire system, which will be balanced and regulated by a storage battery to be put shortly in a substation nearer the centre of distribution. The fields of these rotaries are of iron instead of steel, as with the larger machines, and they are notable for the heavy commutators and collector rings as compared with the iron of the magnetic circuit. This is, of course, to be expected in machines of this low voltage. They are supplied by three 75-kw transformers, located on a gallery nearby, transforming down from the 352 volts of the station input to 80 volts. In the primary leads of these transformers there is an induction regulator giving any desired rise or fall of the voltage up to 5 per cent. in either direction. An opportunity for further regulation of the pressure at the direct-current end is provided by reactive coils in the 80-volt circuits and a wide range of variation of the field magnetization, giving a possble variation of the direct-current pressure of 15 per cent. The reactive coils are each in two sections, one to remain in the circuit permanently and the other to be inserted for starting from the alternating-current end. These machines are in a certain sense experimental, as it is feared that the variations in the drop of the Niagara-Buffalo line will come in through the converters to too great an extent for incandescent lighting work, and extensions of the system may be carried out by motor generators if this proves to be the case.

THE ALTERNATING MOTOR GENERATORS.

The largest machines in the whole installation are two 425-kw synchronous motors, each coupled to a 400-kw generator, taking power at 352 volts, 3-phase, 25-cycle, and delivering 2200 volts, 2-phase, 62½ cycles. These are used to supply the existing 2200-volt alternating-current lines of the company in preference to frequency changers, which might have been used, and would have required a smaller double transformation of electrical into mechanical and mechanical into electrical power. The preference is due to the independence the motor-generator combination gives of variations in the voltage of the incoming power. With frequency changers the voltage given out is proportional to the pressure of the source of power, while with synchronous motor generators the only factor of the power-supplying lines that can affect the output is the frequency, since the motor runs in synchronism with the generators supplying it within a wide range of voltage delivered.

Both motor and generator are of the revolving-field type, the number of poles of the motor being eight, giving a speed of 375 r. p. m., and that of the generator twenty, giving a frequency ratio of 25 to 62½. The two machines (see Fig. 11) are mounted on one cast bed-plate, with four pedestals and a coupling between the two inboard bearings. The field supports are shimmed up, so that they may be lowered, as the armature brasses wear down, to maintain proper concentricity. While the dynamos are only rated at 400 kilowatts, they are guaranteed to carry 500 kilowatts for two hours.

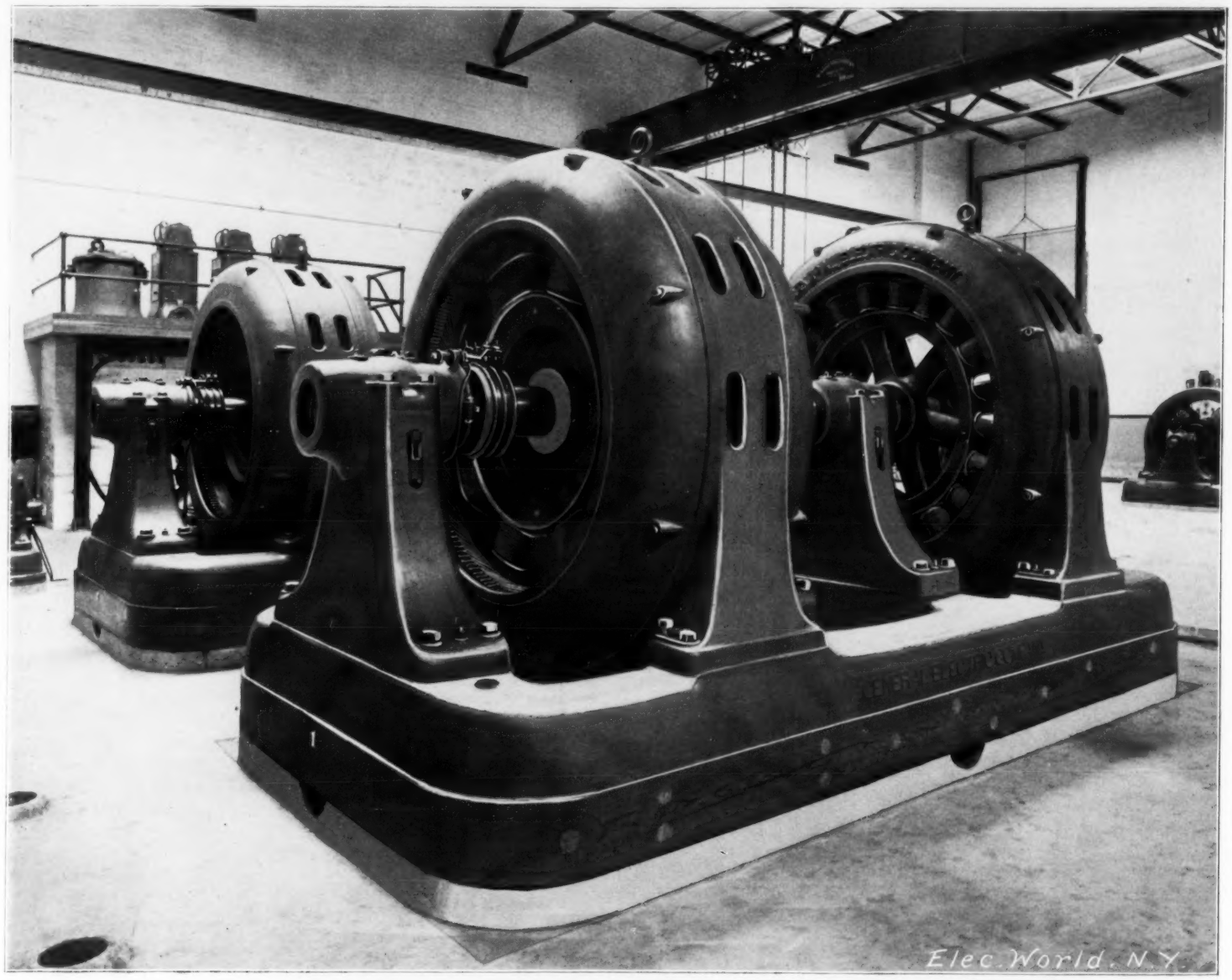


FIG. 11.—THE MOTOR GENERATORS TRANSFORMING FROM 25 CYCLES, 352 VOLTS AND 3 PHASES TO 62½ CYCLES, 2200 VOLTS AND 2 PHASES.

These transforming sets have also two switchboards, one for controlling and measuring the incoming power to the motors, and the other the outgoing power from the generators. The motor board (see Fig. 14 and diagram 2) has double-throw switches for starting the machines in the down position and for running in the up position, the motors being started against frictional load in the same way as the others described above, but in this case a one to one compensating transformer is used instead of reactive coils, to give half voltage in starting. This transformer consists simply of three

windings, one for each phase, all in one case, connected between the lines in a Y-group and tapped out at their middle points to give the machine on starting one-half the voltage between terminals. The main difference between the action of compensators and reactive coils in such work is that the reactive coil requires from the line as many amperes as the motor demands for starting, which is generally several times full-load current with hysteresial torque, the only value of the coil being to check a still greater and unnecessary flow of current, while the compensating transformer demands from the line a current less than that required by the machine in proportion as the voltage is lowered, and does not introduce such a heavy wattless lagging component. The compensator has, of course, to be independently cut out of the circuit after its duty in starting the motor is accomplished, and this is done in this installation by a double-pole switch, one corner of the 3-phase circuit being left in permanently. Reactive coils give a better start, but disturb the line more, a disadvantage negligible in this plant except on the largest motors, which are therefore fitted with compensators.

The generators are connected to their switchboards through potential regulators, one in each of the two phases, giving (see Fig. 15) by movements of a quick-break rotating switch manually operated over eight contacts—a 4 per cent. regulation up or down in one-half of 1 per cent. steps, the boosting effect being reversible. The generator board has two machine panels, each fitted with two edgewise ammeters, four single-pole main switches separated by double barriers, a field switch and rheostat, etc., and four pull-away fuses. The board carries four buses, two for each phase, running across the instrument panel to the two feeder panels. The instrument or total output panel contains voltmeters, electrostatic ground detectors and integrating wattmeters, the absence of any synchronizing arrangements being due to the fact that the machines never by any possibility can get out of synchronism, since the motor ends must remain in synchronism and the change of the angular relation of the motor ends, by any odd integral number of cycles, will cause the dynamo ends to be exactly opposed to each other in phase, which can easily be recognized and corrected by starting up again.

The feeder panels are fitted for eight feeders—all single-phase—which are supplied with current through oil switches of a novel form. Each of these consists of inverted U-shaped copper links coming down into contacts under an oil bath contained in a tin case surrounding each switch, two of these single-pole, double-break links being mechanically connected to the switch-handle on the front of the board, and electrically connected to the opposite terminals of one feeder. The switches are intended to open any overload or short that may come on the system, and have under test opened 800 amperes at 3000 volts.

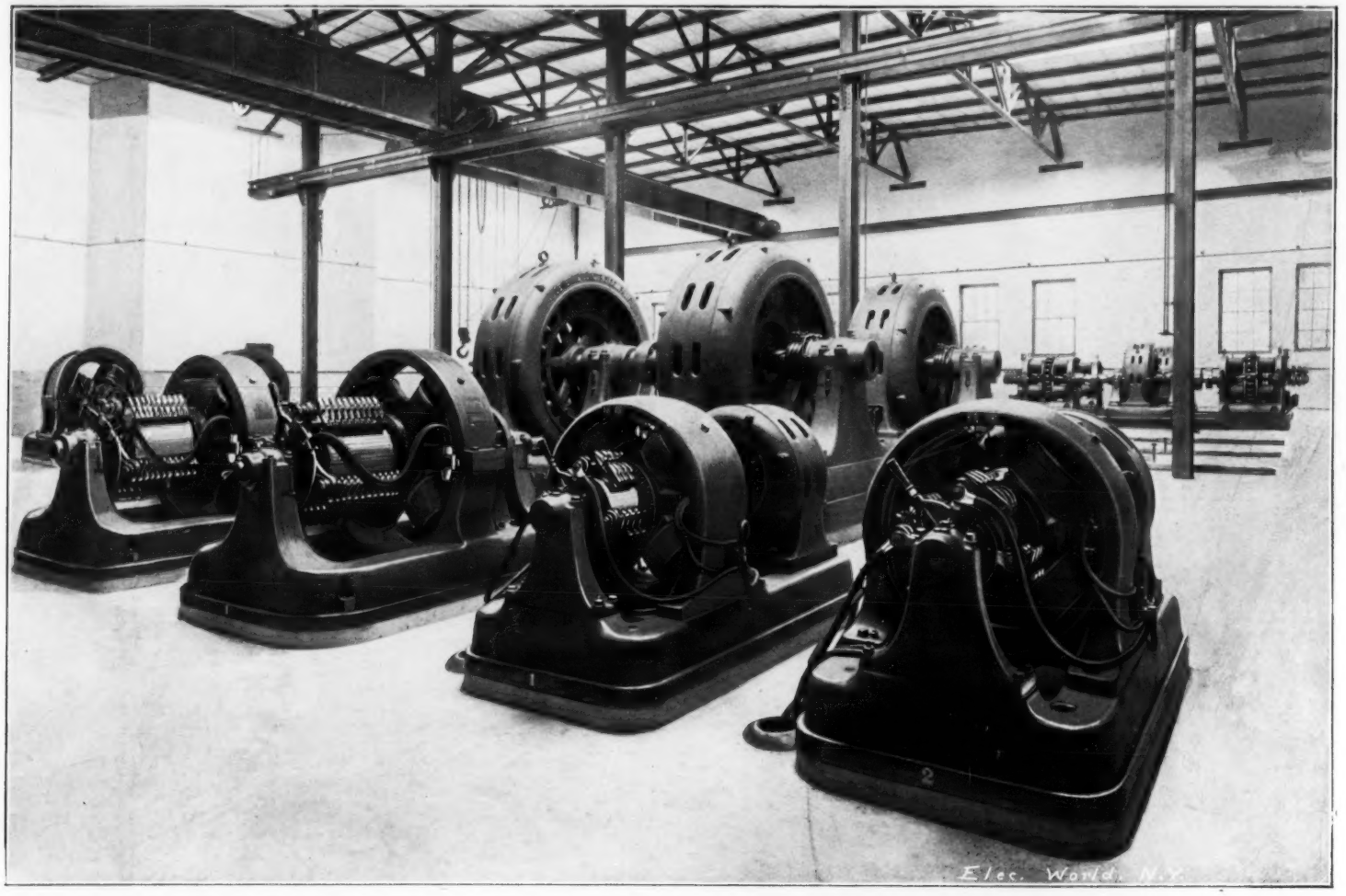
THE EXCITERS.

Current for exciting all the synchronous motors and the alternating-current generators is derived from two 20-kw, 125-volt machines, each direct-coupled to an induction motor with a short-circuited or "squirrel-cage" armature. (See Fig. 12.) The two dynamos are compound-wound, and run in parallel with the usual equalizer connections, and the two motors are controlled by triple-pole fused switches and a compensator. (See Fig. 13.)

CONCLUSION.

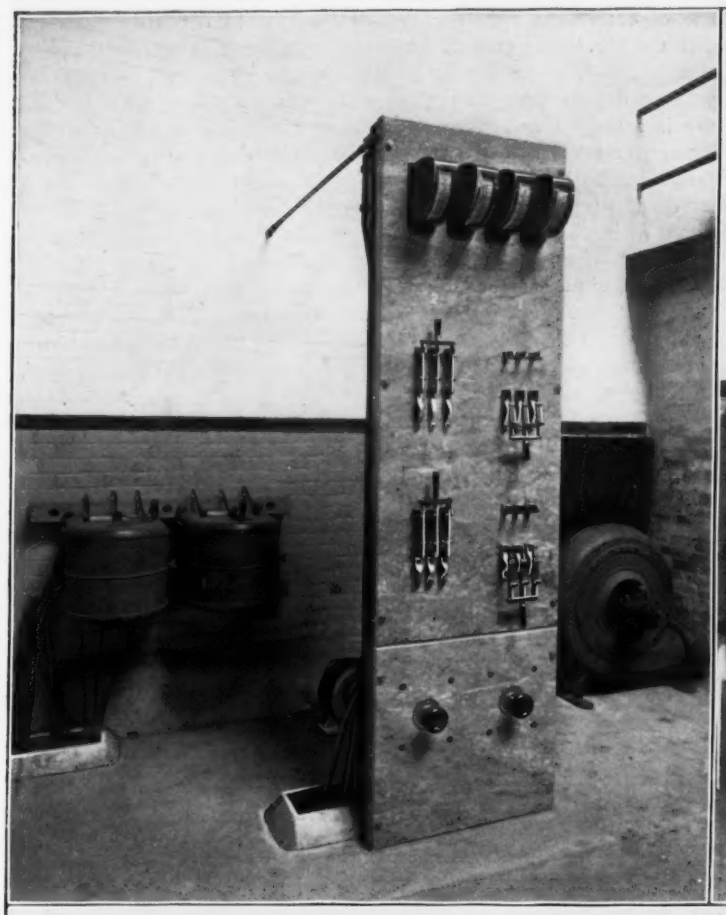
The whole station is laid out with the aim of minimizing operating expenses, the feature of attendance having had particular attention. Alternate rows of machines, for example, are fitted with oil cups, switch handles, brush-rocking handles, etc., all turned in to alternate aisles, so that an attendant passing down one aisle can reach everything which it may be desired to manipulate on two rows of machines, the switchboards for the same being located so far as possible at the ends of the same aisles. A small motor-driven air compressor has been installed to give air for blowing dust out of the machines, and also for blowing out arcs on the boards in case of any emergency requiring this precaution. All the apparatus was manufactured and installed by the General Electric Company.

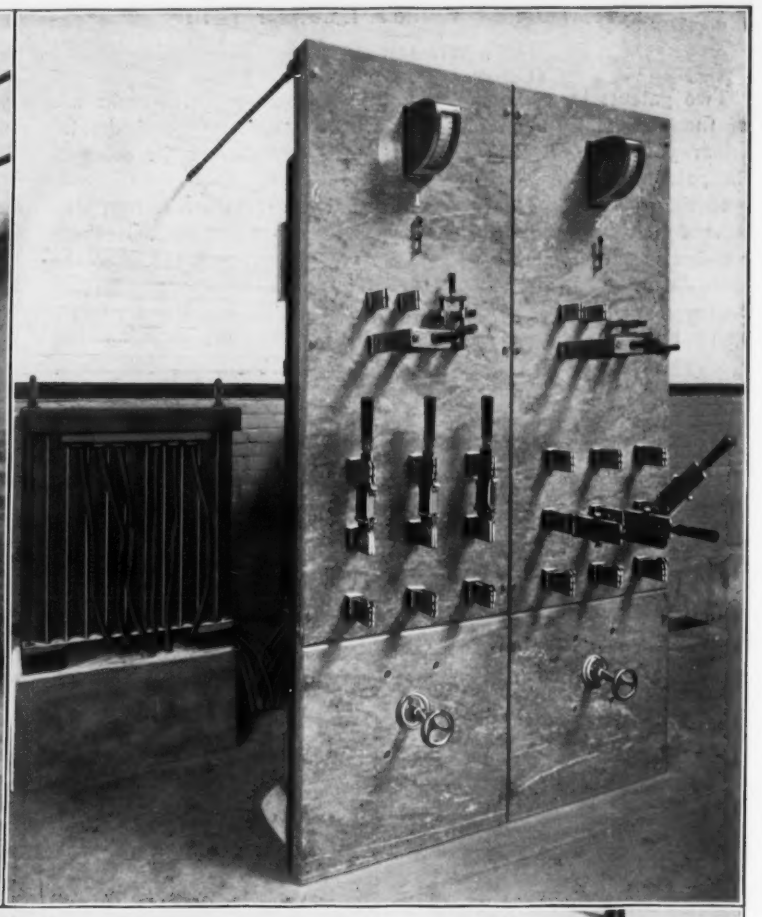
The whole work has been in charge of Mr. Charles R. Huntley, general manager of the Buffalo General Electric Company, and under the immediate supervision of Mr. H. G. Stott, electrical superintendent of the same company, and many of the original solutions of the novel problems involved attest the managing ability of the former and the inventive faculties of the latter.



The 550 Volt Converters. The Alternating Motor Generators. Two of the Arc Units.
The 125-Volt Converters. The Exciter Sets.

FIG. 12.—A GENERAL VIEW SHOWING ALL TYPES OF MACHINES USED.





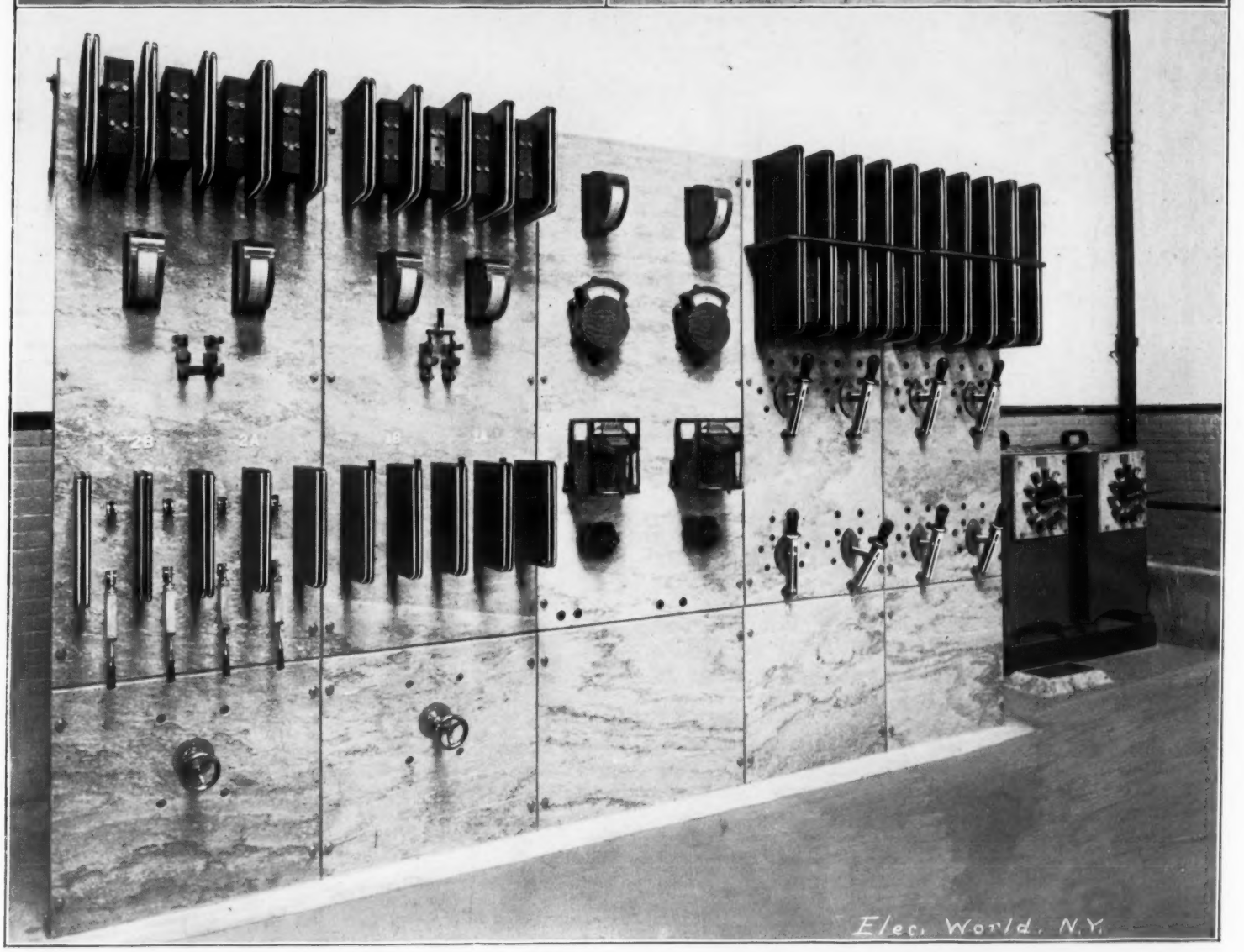


FIG. 13.—SWITCHBOARD AND COMPENSATORS OF THE EXCITER SETS. FIG. 14.—SWITCHBOARD AND COMPENSATORS OF 425-KW MOTORS.
FIG. 15.—THE 62½-CYCLE SWITCHBOARD. GENERATOR PANELS TO THE LEFT. INSTRUMENT PANELS AT THE CENTRE. OUTGOING FEEDER PANELS TO THE RIGHT. REGULATING BOOSTERS TO THE EXTREME RIGHT.

Telegraphing Without Line Wires—III.

By William Bissing.

(Concluded from last issue.)

Two patents have been granted in this country which make use of the method of signaling by electrical waves. One is the familiar patent to Marconi, 586,193, July 13, 1897, and the other is the patent to Lodge, 609,154, August 16, 1898.

In the patent to Marconi, Figs. 11 and 12 represent the transmitter and receiving apparatus when used for short distances. In them *c* indicates the induction coil, whose secondary is connected to the balls *d;* the primary is closed through the key *b*. *f* is a reflecting mirror of metal, and the sparking apparatus is placed at its focus. The spheres *e* lie between the knobs *d*, and when the induction coil sparks across at *d* it also of course produces sparking at *e*. This spark is the result of an oscillatory charge which is induced on the sphere *e*, and which sends out waves through the ether to the receiver, Fig. 12. This receiver consists of the coherer *j*, a glass tube containing metallic powder, each end of the column of powder being connected to a metallic plate *k* of suitable length to cause the system to syntonize electrically with the electrical oscillation transmitted. The tube *j* may be replaced by other forms of imperfect electrical contacts, examples of which are given by Lodge in the monograph above cited.* See the chapter on microphonic detectors. The reflector *l* collects the oscillations and projects them upon the coherer. There are two circuits at the receiver; one is the circuit embracing the coherer, the plates *k*, the battery *g*, and the magnet of the relay *n*; the other includes the battery *r*, the armature of the relay *n* and the trembler *p*. These correspond respectively to the line and local circuit of the ordinary Morse telegraph

*See "The Work of Herz and Some of His Successes."

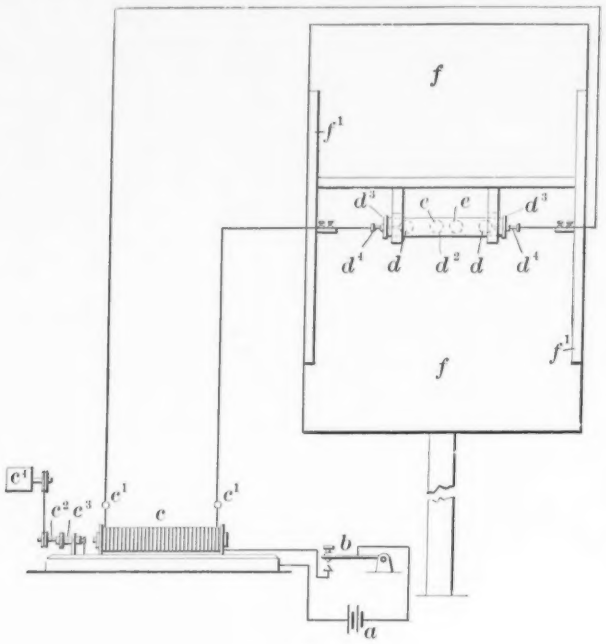


Fig. 11

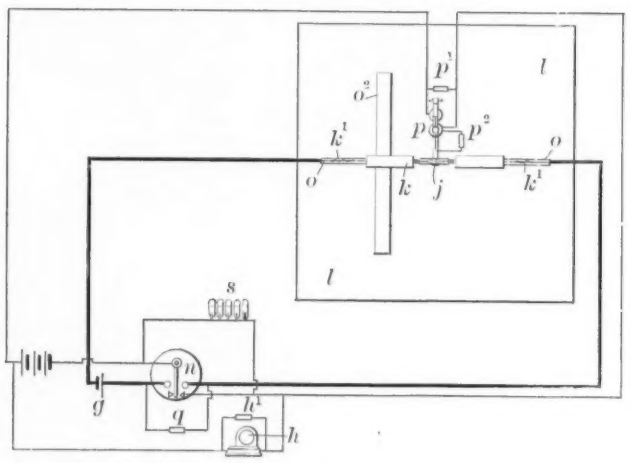


Fig. 12

The object of the trembler or decoherer is to disturb the filings after the spark has passed, and thus once more make their resistance too high to permit the passage of the current of the battery *g*. This decoherer is usually an electromagnetic bell, whose hammer is arranged to strike the coherer tube. The tapping is thus done automatically by the current started by the spark in the tube. In addition to these generic features of the invention there are a number of details which are shown in the figures. A telegraphic receiver *h* is placed in a circuit derived from the trembler bell circuit. The other devices shown at p^1 p^2 h^1 *q* and *s* are non-inductive resistances shunted about the electromagnets or circuit closures to counteract self-induction or prevent sparking. The arrangement usually adopted by Marconi is shown in Figs. 13 and 14, which are taken from Figs. 10 and 11 of the patent. One of the spheres *d* is connected to earth *E* and the other to a plate *u* suspended on a pole *v* and insulated from the earth. At the receiving station, Fig. 14, one terminal of the sensitive tube *j* is connected to the earth *E* and the other to an insulated plate *w* suspended on a pole *x*. The larger the plates of the receiver and transmitter and the higher the plates are suspended from the earth the greater is the distance through which it is possible to communicate. It was pointed out above that this elevation of the plates increased the proportion of the capacity of the plates with respect to each other to their capacity with respect to the earth, which augments the inductive action of one plate on the other. The theory of the coherer has been explained in several ways. The explanation given by Lodge in the monograph above referred to is that a kind of welding action between the particles takes place when the spark passes, which, of course, diminishes the resistance of the body of filings to the passage of the battery current.

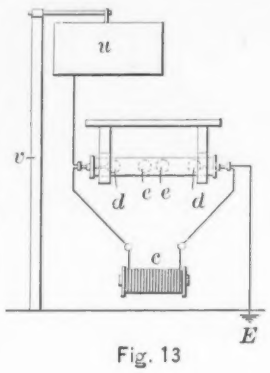


Fig. 13

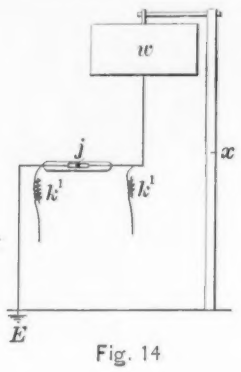


Fig. 14

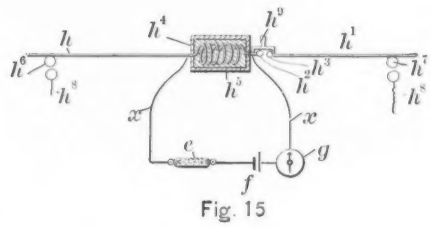


Fig. 15

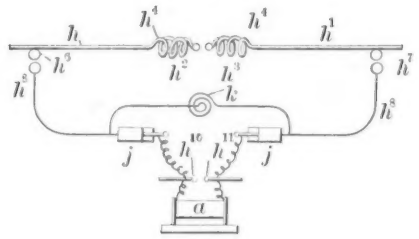


Fig. 16

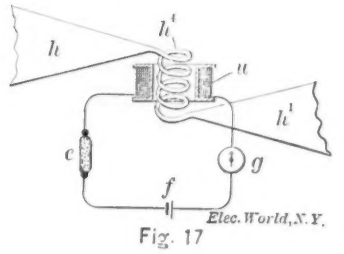


Fig. 17

Elec. World, N.Y.

Marconi describes in the specification a means of adjusting the capacity areas h so that the receiving circuit may syntonise electrically with the oscillations of the transmitter. In most of the experiments carried out by him with this apparatus, however, no tuning was attempted, and in the latest results that have been obtained by Slaby, circuits out of tune were used and a number of the minor features of the invention, such as the high shunted resistances to avoid sparking were omitted.

The patent to Lodge marks an important step in advance in this art. In the first place the waves emitted by the transmitter last longer, i. e., a greater number of waves are sent out at each discharge of the transmitter before they are damped out. Secondly, the receiver can be more effectively tuned or syntonized to respond to a definite pitch of the signaling instrument. Lodge's invention is shown in Figs. 15, 16 and 17, which are copies of Figs. 3, 4 and 13 of the patent.

Fig. 15 shows a combined radiator and receiver. In it h^8 indicates wires leading to the Ruhmkorff or high potential coil: h and h^1 constitute the capacity areas, h^4 is the syntonizing self-induction coil embedded in insulation h^5; h^9 is a sort of circuiting switch; e is the coherer, f the battery and g the receiving instrument. When in use as a radiator the gap between the discharge knobs h^2 and h^3 is left open; when utilized as a receiver the gap is closed by the switch and the coherer, battery and receiving instrument g are connected through a thin wire x from each end of the coil h^4. The above arrangement permits one instrument to be used as a transmitter or receiver by simply throwing a switch. In Fig. 16 a Leyden jar or other suitable condenser j, able to stand a high potential, is interposed in the wires h^8, leading from the Ruhmkorff coil, so that the knobs are supplied from the outer, that is, the uninsulated coat of each jar, while between the inner coats a third spark gap is arranged, called the starting gap, which consists of suitable knobs, h^{10} h^{11}. The outer coats of the jars are joined by an induction coil of thin wire, k, so as to permit thorough charging. When the discharge occurs this wire acts as an alternative path or bypass, but does not prevent the sparks at the supply gap.

In Fig. 17 the syntonizing coil of the resonator is surrounded with another or secondary coil u, constituting a species of transformer. This latter coil is made a part of the coherer circuit, so that it is secondarily affected by the alternating currents excited in the conductor of the resonator. The coherer is thus stimulated by the current in this secondary coil rather than primarily by the currents in the syntonising coil itself, the idea being to thus leave the resonator freer to vibrate electrically without disturbance from attached wires.

The persistance of vibration of the waves of the transmitter is due to the self-induction coil which is inserted between the capacity areas of the radiator. This effect is analogous to that due to increasing the weight, and therefore the moment of inertia of a flywheel which prolongs the number of revolutions the wheel makes, beginning with a given angular velocity, before it comes to rest. The following extract from Helmholtz's "Sencations of Tone," page 62, may make the action of the induction coil clearer by setting forth the parallel case for sounding bodies:

"Bodies of small mass which readily communicate their motion to the air and quickly cease to sound, as for example stretched membranes or violin strings, are readily set in sympathetic vibration. The limits of pitch capable of exciting sympathetic vibration in such bodies are somewhat broad. Massive elastic bodies, on the other hand, such as bells and plates, are not so easily excited. It is necessary to hit the pitch of their tone with much greater nicety in order to make them vibrate sympathetically. They will, of course, continue to vibrate for a longer period than the others."

Attention is called to the persistency of the sounds of heavy elastic bodies and nicety of regulation, which is required to set them in sympathetic vibration, just as in an electric circuit containing an induction coil, as used by Lodge, the oscillations last longer and the syntony is more accurate than when the coil is omitted.

With the patent to Lodge it will be necessary to bring this article to an end. It will be readily granted that there are still numerous problems to be solved in the art of wireless telegraphy. It will be necessary to increase the distance over which transmission may be effected, to add to the certainty and secrecy of the message, to prevent the disturbing and absorptive effects of the intervening media, to increase the sensitiveness without impairing the efficiency of the receiving instrument, before we can hope to replace the Atlantic cable and its costly appurtenances with a pair of syntonized radiators and receivers. October, 1898.

Meeting of the Special Committee of the Underwriters' National Electrical Association.

At the recent annual meeting of the electric committee of the Underwriters' National Electrical Association a special committee was appointed to revise the specifications for wire coverings, look into the subject of fittings to be considered acceptable under the rules, and to take up other matters in connection with the National Electrical Code. This committee held sessions in Chicago January 9, 10 and 11, the proceedings of which are outlined in the following brief minutes:

MONDAY, JANUARY 9.

Meeting called to order by Wm. H. Merrill, Jr., chairman.

Those present were: William H. Merrill, Jr., electrician of the Electrical Bureau of the National Board of Fire Underwriters, chairman; J. C. Forsyth, of the New York Board of Fire Underwriters; E. V. French, of the Associated Factory Mutual Fire Insurance Companies; William McDevitt, of the Fire Underwriters' Association of Philadelphia; A. M. Schoen, of the Southeastern Tariff Association; J. E. Cole, of the Boston Wire Department, and Edward B. Ellicott, city electrician of Chicago.

Acting with the committee were: E. A. FitzGerald, of the Underwriters' Association of New York State; J. M. DeCamp, of the Suburban Underwriters' Association; Wm. S. Boyd, of the Chicago Underwriters' Association; M. L. Stern, of the Denver city electrical department; Edward M. Dexter, electrician, Milwaukee Board of Fire Underwriters; A. A. Pope, of the Edison Illuminating Company, New York; F. R. Jenkins, of the Chicago Edison Company; Prof. D. H. Jackson, of Wisconsin University, Madison, Wis.; R. L. Pierce, of the American Institute of Electrical Engineers, and Franklin H. Wentworth, Theodore Varney, and Benjamin H. Glover, of the Electrical Bureau of the National Board of Fire Underwriters.

The following was adopted to replace Rule 41, b, of the code:

METAL CONDUITS WITH LINING OF INSULATING MATERIAL.

b. "The metal covering or pipe must be equal in strength to the ordinary commercial forms of gas pipe of the same size, and its thickness must be not less than that of standard gas pipe as shown by the following table:

Size, inches.	Thickness of wall, inches.	Size, inches.	Thickness of wall, inches.
½	.109	1¼	.140
⅝	.111.	1½	.145
¾	.113	2	.154
1	.134		

"An allowance of $^{2}/_{100}$" variation in manufacturing and loss of thickness by cleaning will be permitted."

The following amendment to Rule 41, j, was adopted: Rule and heading to read:

UNLINED METAL CONDUITS.

j. "Plain iron or steel pipes of equal thickness and strengths specified for lined conduits in Rule 41, b, may be used as conduits provided their interior surfaces are smooth and free from burs; pipe to be galvanized, or the interior surfaces coated or enameled, to prevent oxidization, with some substance which will not soften so as to become sticky and prevent wire from being withdrawn from the pipe."

On motion Rule 8, e, was altered at written suggestion from American Institute of Electrical Engineers, to read: "Must not be run in series multiple or multiple series except on constant potential systems, and then only by special permission from inspection department having jurisdiction." Adjourned.

TUESDAY, JANUARY 10.

Both sessions were given up to discussion of experimental records of products from various factories manufacturing insulated wire. Representatives of the manufacturers were severally present during the time devoted to discussion of their products, answering the inquiries of the committee as to factory methods, original tests, etc. The following manufacturers of rubber-covered wire and cables were represented:

American Electrical Works, Messrs. Remington and Donohue.
Bishop Gutta Percha Company, by Mr. H. D. Reed.
Eastern Electric Cable Company, by Mr. Eustis.
Simplex Electric Company, by Messrs. Mason and Hixson.
Canadian General Electric Company, by Mr. Watts.
John A. Roebling's Sons Co., by Messrs. Neubery and Sewell.
Washburn & Moen Company, by Messrs. Pietzeker and Smith.
Crefeld Electrical Works, by Messrs. Lockwood and Bibber.
New York Insulated Wire Company, by R. E. Gallaher.

Safety Insulated Wire & Cable Co., by Messrs. Clark and Austin.
Indiana Rubber & Insulated Wire Co., by Messrs. Lucas and Love.
W. R. Brixey (Kerite), by Geo. F. Porter.
Okonite Company (Ltd.), by Messrs. Manson and McKinlock.
National India Rubber Company, by Mr. Hodgkinson.
General Electric Company, by W. L. Clark.
Standard Underground Cable Company, by Mr. Connot.
Crescent Insulated Wire and Cable Company, by Mr. Murray.
Phillips Insulated Wire Company, by letter.
Alfred F. Moore, by letter.

WEDNESDAY, JANUARY 11.

The following representatives of the manufacturers of wire, acting with the committee appointed to consider the matter of wire coverings and standard specifications for the same, were present at the opening of the meeting:

Messrs. Smith, of the Washburn & Moen Company; Remington, of the American Electrical Works; Gallaher, of the New York Insulated Wire Company; Clark, of the General Electric Company and Canadian General Electric Company; Clark, of the Safety Insulated Wire Company; Manson, of the Okonite Company; Hodgkinson, of the National India Rubber Company; Reed, of the Bishop Company; Eustis, of the Eastern Electric Cable Company; Mason, of the Simplex Company; Connor, of the Standard Underground Cable Company; Bailey, of Roebling's Sons Company; Murray, of the Crescent Company, and Lucas, of the Indiana Rubber and Insulation Company.

The following specifications for rubber-covered wires and cables were adopted:

40, A. RUBBER COVERED.

Copper for such conductors, except as hereinafter specified, must be thoroughly tinned and must never vary in diameter so as to be more than $^{3}/_{1000}$ of an inch less than the specified size.

INSULATION.

(1) Low-potential systems. 300 volts or less.

Insulation for use on low-potential systems must be of an approved compound and be of a thickness not less than that given in the following table for B. & S. gauge sizes:

From	18 to	16	inclusive	$^{1}/_{32}$"
"	14 to	8	"	$^{3}/_{64}$"
"	7 to	2	"	$^{1}/_{16}$"
"	1 to	0000	"	$^{5}/_{64}$"
"	to	500000	C. M.	$^{3}/_{32}$"
"		1000000	"	$^{7}/_{64}$"
larger than		1000000	"	$^{1}/_{8}$"

Measurements of insulating wall are to be made at the thinnest portion of the dielectric. The completed coverings must show an insulation resistance of at least 100 megohms per mile during thirty days' immersion in water at 70° Fahr.

Rule 16. Heading to read: "Below is a table showing the allowable carrying capacity of wires and cables of 98 per cent. conductivity, according to the standard adopted by the American Institute of Electrical Engineers." Adopted.

Rule 24, g. Change "weatherproof" to "slow-burning weatherproof." Adopted.

Rule 40, b.—1.—SLOW-BURNING WEATHERPROOF.

This character of insulation on wires shall consist of two coatings, the inner one to be fireproof in character, the outer to be weatherproof. Wire with this insulation must conform to, or be in excess of, the measurements given in the following table, which shows standard thickness of insulating walls for standard wires and cables:

Size B. & S.	Thickness of wall of Insul. Fireproof coat.	Weatherproof coat.	Total outside diameter. In mils.	In 32ds approx.
18	.042	.015	0.154	5
16	.042	.020	0.175	5½
14	.042	.020	0.188	6
12	.042	.020	0.205	6½
10	.050	.029	0.260	8½
8	.050	.029	0.286	9
6	.050	.029	0.320	10½
5	.050	.029	0.340	11
4	.054	.029	0.370	12
3	.054	.029	0.395	12½
2	.070	.029	0.455	14½
1	.070	.038	0.505	16
0	.110	.048	0.641	20½
00	.110	.057	0.699	22½
000	.110	.057	0.744	24
0000	.110	.057	0.794	25½

The inner or fireproof coat to be layers of cotton or other thread, the outer one of which must be braided. All the interstices of these layers are to be filled with the fireproofing compound. This is to be material whose solid constituent is not susceptible to moisture, and which will not burn even when ground in an oxidizable oil, making a compound, which, while proof against fire and moisture, at the same time has considerable elasticity, and which, when dry, will suffer no change at a temperature of 250° Fahr., and which will not burn at even higher temperature.

The weatherproof coat to be a stout braiding, thoroughly saturated with a dense moisture-proof compound thoroughly slicked down, applied in such manner as to drive any atmospheric moisture from the cotton braiding, thereby securing a covering to a great degree waterproof and of high insulating power. This compound to retain its elasticity at zero Fahr. and not to melt at 180° Fahr.

2.—SLOW BURNING.

This wire shall be the same as the "Slow-Burning Weatherproof," except that the outer braiding shall be impregnated with a fireproofing compound similar to that required for the interior layers and with the outer surface finished smooth and hard.

Note.—This "slow-burning" wire shall only be used with special permission of the inspection department having jurisdiction.

3.—WEATHERPROOF LINE WIRE.

The insulating covering shall consist of at least three braids thoroughly impregnated with a dense moisture repellant, which will not melt at a temperature lower than 125° Fahr. The thickness of insulation shall be not less than one-sixteenth inch for No. 8 wire and smaller, and for all others not less than three-thirty-secondths inch. The outer surface shall be thoroughly slicked down. Adopted subject to revision.

Each foot of the completed covering must show a dielectric strength sufficient to resist throughout five minutes the application of an e. m. f. of 3000 volts per 1-64-inch thickness of insulation under the following conditions:

The source of alternating e m. f. shall be a transformer of at least 1 kilowatt capacity. The application of the e. m. f. shall first be made at 4000 volts for five minutes and then the voltage increased by steps of not over 3000 volts, each held for five minutes until the rupture of the insulation occurs. The tests for dielectric strength shall be made on a sample of wire which has been immersed for seventy-two hours in water, 1 foot of which is submerged in a conducting liquid held in a metal trough, one of the transformer terminals being connected to the copper of the wire and the other to the metal of the trough.

(2) High-Potential Systems, 300 to 600 Volts.—The requirements shall conform to those for wires for low-potential systems—0 to 300 volts.

(3) High-Potential Systems, 600 to 3000 volts.—The thickness of the insulating walls must not be less than those given in the following table for B. & S. sizes:

From 14 to 1, inclusive, $^{3}/_{32}$". 0, B. & S. to 500,000 cm, inclusive, $^{5}/_{32}$" and a tape and a braid, or two braids. Over 500,000 cm, inclusive, $^{4}/_{32}$" and a tape and a braid, or two braids.

The requirements shall conform to those for wires for low-potential systems, with the exception that an insulation resistance of not less than 300 megohms per mile shall be required.

(4) Extra high potential systems, 3000 volts and over.

Wire for arc light circuits exceeding 3000 volts potential shall have an insulating wall not less than $^{6}/_{32}$" in thickness, and shall withstand a breakdown test of at least 30,000 volts, and have an insulation of at least 500 megohms per mile. The tests on this wire to be made under the same conditions as for low-potential wires.

Note.—The committee of the whole concluded that the somewhat complex conditions existing with alternating currents exceeding 3000 volts' difference of potential made it inexpedient to specify general insulations for this use.

All of these insulations must be protected by a substantial braided covering properly saturated with a preservative compound and sufficiently strong to withstand all the abrasion likely to be met with in practice, and sufficiently elastic to permit all wires smaller than No. 7 B. & S. gauge to be bent around a cylinder with twice the diameter of the wire without injury to the braid.

40, E, CONDUIT WIRE.

Must comply with the following specifications:

(1) For metal conduits having a lining of insulating material, single wires and all duplex, twin and concentric conductors must comply with section a of this rule, and must have each conductor

separately braided or taped and a substantial braid covering the whole.

(2) For unlined metal conduits, conductors must conform to the specifications given for lined conduits, and in addition have a second outer fibrous covering at least 1/32 of an inch in thickness, and sufficiently tenacious to withstand the abrasion of being hauled through the metal conduit.

The following was adopted by the joint meeting:

Resolved, All wires and cables designed to meet these specifications hereafter placed upon the market must be plainly tagged or marked, as follows:

First—The maximum voltage at which the wire is designed to be used.

Second—The words, "National Electrical Code Standard."

Third—Name of the manufacturing company, and, if desired, trade name of the wire.

Fourth—Month and year of the manufacture.

This resolution was passed by individual affirmative votes registered by all the manufacturers represented at this time, as follows, and the whole adopted by the meeting unanimously:

Mr. Remington, of the American Electrical Works; Mr. Eustis, of the Eastern Electric Cable Company; Mason, of the Simplex Electrical Company; Clark, of the General Electric Company and Canadian General Electric Company; Newberry, of Roebling's Sons Company; Smith, of Washburn & Moen; Gallaher, of the New York Insulated Wire Company; Clark, of the Safety Insulated Wire Company; Lucas, of the Indiana I. W. Company; Hodgkinson, of the N. I. R. Company; Connor, of the Standard Underground Cable Company, and Murray, of the Crescent Insulated Wire Company.

THURSDAY, JANUARY 12.

The following specifications for flexible cords were adopted:

All flexible cord must be made of stranded copper conductors, each strand to be not larger than No. 26 or smaller than No. 30 B. & S. gauge, and each stranded conductor must be covered by an approved insulation and protected from mechanical injury by a tough braided outer covering, which shall also be slow burning.

A—CORD FOR PENDANT LAMPS.

In this class is to be included all flexible cord which under usual conditions hangs freely in air and which is not likely to be moved sufficiently to come in contact with surrounding objects.

(a) Each stranded conductor must have a carrying capacity equivalent to not less than a No. 18 B. & S. gauge. (b) The covering of each stranded conductor must be made up as follows: 1. A tight, close wind of fine cotton. 2. The insulation proper.

(a) This insulation must be solid, at least one-thirty-second of an inch thick, and must show an insulation resistance of 50 megohms per mile throughout two weeks' immersion in water at 70° Fahr., and stand the tests prescribed for low-tension wires as far as they apply. (b) Or must be at least one-thirty-second of an inch in thickness and composed of substantial, elastic, slow-burning materials, which will suffer no damage at a temperature of 250° Fahr.

Note.—The latter covering must only be used in permanently dry places; the former in other places where cord is allowed, such as basements, cellars and locations having moist atmospheres.

3. The outer cover of silk or cotton. This cover should be so put on and sealed in place that when cut it will not fray out. All cotton to be used on the cord should be impregnated with a flameproof paint which will not have an injurious effect on the insulation.

B—CORD FOR PORTABLES.

In this class is included all cord used on portable lamps, small portable motors, etc.

Flexible cord for portable use must conform to requirements 2 a for pendant cord and in addition be provided with a reinforcing cover especially designed to withstand the abrasion it will be subject to in the uses to which it is to be put.

C—CORD FOR PORTABLE HEATING APPARATUS, SUCH AS IRONS, ETC.

1. A tight, close wind of fine cotton.
2. Thin layer of rubber about 1-100 inch thick, or other cement—in material.
3. Layer of asbestos insulation at least 3-64 inch thick.
4. Stout braid of cotton.
5. Outer reinforcing cover.

This cover to be especially designed to withstand abrasion.

Note.—This cord is in no sense waterproof, the thin layer of rubber being specified in order that it may serve merely as a seal to help hold in place the fine cotton and asbestos, and it should be so put on as to accomplish this.

Amendment to Rule 24, t:

When from the nature of the case it is impossible to place concealed wiring on non-combustible, insulating supports of glass or porcelain an approved armored cable (single or twin conductors, see Rule 40, f) may be used if it is installed without joints between outlets and the cable armor properly enters all fittings and is rigidly secured in place; or, if the wires are not exposed to moisture they may be finished on the loop system if separately encased throughout in approved flexible tubing or conduits. Passed.

Rule 40, f.—Armored Cable—The armor of such cables must be at least equal in thickness and of equal strength to resist penetration by nails, etc., as the armor or metal coverings of metal conduits (see Rule 41, b).

The conductors in same, single-wire or twin conductors, must have an insulating covering as required by section "a" of Rule 40, any filler used must be impregnated with a moisture repellent, and the whole must have a separate exterior covering of insulating material at least one-thirty-second of an inch in thickness, conforming to the insulation standard given in Rule 40, and covered with a substantial braid. Passed.

A Simple and General Method of Obtaining the Virtual Value of an Alternating Current or Electromotive Force.

BY SAMUEL J. BARNETT.

Let the alternating current or e. m. f. be denoted by J. J can always be expressed with perfect generality by the trigonometric series

$$J = A_1 \sin \omega t + A_2 \sin 2 \omega t + \ldots + B_1 \cos \omega t + B_2 \cos 2 \omega t + \ldots, \qquad (1)$$

where $\omega = 2\pi \times$ frequency of alternator. From (1)

$$J^2 = A_1^2 \sin^2 \omega t + A_2^2 \sin^2 2 \omega t + \ldots + B_1^2 \cos^2 \omega t + B_2^2 \cos^2 2 \omega t + \ldots + \sum K_{m,n} \left.\begin{matrix}\sin \\ \text{or} \\ \cos\end{matrix}\right\} m \omega t \cdot \left.\begin{matrix}\sin \\ \text{or} \\ \cos\end{matrix}\right\} n \omega t, \qquad (2)$$

in the last term of which either m and n are different or the product contains both the sine and the cosine of the same angle. To find the mean value of J^2 we must obtain and sum up the mean values of the separate terms. Now, in general,

$$2 \left.\begin{matrix}\sin \\ \text{or} \\ \cos\end{matrix}\right\} m \omega t \cdot \left.\begin{matrix}\sin \\ \text{or} \\ \cos\end{matrix}\right\} n \omega t = \pm \left\{\begin{matrix}\sin \\ \text{or} \\ \cos\end{matrix}\right\} (m - n) \omega t \pm \left.\begin{matrix}\sin \\ \text{or} \\ \cos\end{matrix}\right\} (m + n) \omega t \Bigg\}, \qquad (3)$$

and, as particular cases,

$$\begin{aligned} 2 \sin^2 n \omega t &= 1 - \cos 2 n \omega t \quad (a) \\ 2 \cos^2 n \omega t &= 1 + \cos 2 n \omega t \quad (b) \\ 2 \sin n \omega t \cdot \cos n \omega t &= \sin 2 n \omega t \quad (c) \end{aligned} \qquad (4)$$

Since the mean value of any sine or cosine is zero, the mean value of every term of the summation $\sum K_{m,n} \left.\begin{matrix}\sin \\ \text{or} \\ \cos\end{matrix}\right\} m \omega t \cdot \left.\begin{matrix}\sin \\ \text{or} \\ \cos\end{matrix}\right\} n \omega t$ must vanish by (3) and (4, c); moreover, from (4, a and b) the mean value of the square of any sine or cosine is equal to ½. Therefore

$$\text{Mean } J^2 = \tfrac{1}{2}(A_1^2 + A_2^2 + A_3^2 + \ldots + B_1^2 + B_2^2 + B_3^2 + \ldots),$$

and

$$\sqrt{\text{Mean } J^2} = \text{Virtual } J = \frac{1}{\sqrt{2}} \sqrt{A_1^2 + A_2^2 + A_3^2 + \ldots + B_1^2 + B_2^2 + B_3^2 + \ldots}.$$

We have thus obtained the most general expression for the quantity sought with the use of no mathematics beyond the most elementary trigonometry; while the infinitesimal calculus has been invariably employed in the methods hitherto given.

The Twentieth Century Wayside Inn.

A company is being promoted in Brussels with a capital of £320,000 with the intention of erecting charging stations for automobile vehicles at intervals of 10 or 12 miles on the main roads in France and Belgium. These are to be equipped with apparatus for charging storage batteries and also fuel for the replenishment of petroleum engines and means for repairing all classes of automobiles. Restaurants, bars, and even medical attendance, are also to be provided.

CONVENTION OF THE NORTHWESTERN ELECTRICAL ASSOCIATION

The seventh annual convention of the Northwestern Electrical Association was held in the club room of the Hotel Pfister, Milwaukee, Wis., on Wednesday, Thursday and Friday, January 18, 19 and 20. The following is a brief account of the proceedings as extracted from the secretary's minutes:

PROCEEDINGS OF FIRST SESSION, JANUARY 18.

The convention was called to order in the appointed place by President F. A. Copeland at 12:10 P. M. The programme of the convention was presented, the calling of the roll was dispensed with, the minutes of the last convention as published were approved, the reading of the president's address was deferred until the afternoon session, the report of the secretary and treasurer was presented and adopted, the announcements of entertainments and banquet were made and applications for membership were read.

QUESTION BOX.

The questions presented in the question box were then taken up for discussion, the first being "What is the best way to enlarge the arc, incandescent and motor capacity of a plant that is now 'filled up' in all departments?"

To answer this Mr. H. L. Doherty suggested the addition of a new machine in one division of the system, arranged to also relieve in part the load on the others; for example, a new alternator could be put in with some alternating arc lamps to lighten up the load on the arc machines. Mr. W. S. Schott considered that the best way would be to put the incandescent and power load on a meter basis. Mr. S. B. Livermore suggested the use of incandescent lamps of a higher economy—3.6 watts in place of 4 watts—and improved transformers, citing the contemplated change in the plant with which he is connected in Winona, Minn., where forty-nine old-type, two-wire transformers are to be replaced with eleven connected to three-wire circuits.

Mr. E. L. Debell acknowledged the responsibility for the question, and described the conditions of the plant in Sheboygan, Wis., to which the problem applies. There the greater part of the business is already done on a meter basis, necessitated by the growing overload three years ago. As an immediate result of the change from a 4-watt to a 3½-watt lamp, and the substitution of meters for flat rates, a 60-kw machine did the work previously requiring two of the same size, reducing the income at first, but now giving very satisfactory operation and a full load to the equipment.

Mr. George L. Thayer described the solution of a similar problem at Cedar Rapids, Ia., where the plant is one typical of the old style, with alternating circuits, carrying small transformers, 500-volt power and series arc lines. The station being loaded, the company began last year putting in two-phase alternators, changing over its power-load to two-phase motors wherever practicable, and remodeling its transformer system. The purpose is to eventually throw out the 500-volt system and run the commercial arcs on the alternating lines.

Mr. T. F. Grover cited instances of two plants which he had changed over from a contract to a meter basis in which the revenue went down the first year about 20 per cent., the operating expenses decreasing about 33 per cent.; but the revenue increased the second year 50 per cent., the operating expenses remaining about 30 per cent. below those under a contract basis.

The meeting then adjourned.

PROCEEDINGS OF AFTERNOON SESSION, JANUARY 18.

The first matter of business was the address of President F. A. Copeland, a few extracts from which are as follows:

There are several matters of more or less importance to which I call your attention. One of them is the question of summer meetings. As you know, our articles of incorporation provide for two meetings a year, on the third Wednesday of January and July, respectively.

It has been suggested that the interests of the association would be best subserved by having but one meeting a year, the main reason advanced therefor being that the summer meetings are but sparsely attended by central-station members; they are therefore of little value.

Another question is whether we should not adopt some systematic plan of compiling and issuing to members published articles of interest to our members, such as articles on municipal ownership, be they in favor of corporations or municipalities; reports of cities operating their own plants, or any other matter that would be of benefit to members of this association.

I would suggest that a committee consisting of the secretary and two members be appointed to collect data, etc., that in their judgment would be of value to the members, have it compiled in suitable shape for filing, and copies sent to each member. To assist this committee I would suggest that each member, on seeing an article on any subject he thinks of interest, cut it out and mail it to the secretary. We could in time form a valuable pamphlet for ready reference.

Another suggestion is that we have a representative at each State capital in our territory, either a member of the association or some one in our employ, to examine all bills introduced in the Legislatures and report promptly on those that in any way affect electrical interests. His report could be made directly to the chairman of the legislative committee, and could then decide the action necessary.

As our association has grown to be quite a factor in the electrical world, and in order to command the respect that is due us, it has become necessary to increase the work in the secretary's office. There are few of you who realize the amount of time and labor required to run his office; similar institutions pay their secretaries a salary. It is not necessary to state the exorbitant salary ours receives. I would suggest you take this matter up and adjust the salary to somewhere compensate for the labor that it involves.

I would also suggest that the dues of members be raised to $10 per year, as the present dues are not adequate for running the association on the lines they should be. The dues of the National Association are $25, the Edison Association $106.50, and I am sure our association is of as much value to its members.

The question of legislation affecting central stations was then taken up, and after a discussion as to the advisability of the association as a whole attempting to influence the legislation in any one or more of the Northwestern States, which might better be undertaken by individual State associations, the matter was referred to a committee.

Mr. B. J. Arnold then read a paper on the subject of "The Trend of Central-Station Design," an abstract of which will appear later in these columns. In the discussion which followed Mr. Arnold yielded to the requests for a detailed description of the Arnold system, and explained in greater detail the use of cooling towers, after which Mr. E. L. Debell, of Sheboygan, read a paper on the subject of "Meter-Rate Systems."

In the discussion which followed, Mr. S. B. Livermore described the experience of the station with which he is connected in Winona, Minn. Originally with no meters, it now supplies 50 per cent. of its customers through meters, and he advised managers to figure up the proportion of their loads which is metered and the earnings upon it, and the proportion unaccounted for, as shown by station meters, the only return from which is the flat-rate income, and compare the two rates per kw hour. He considered that all doing so would be—as he was—very much astonished. He advised

dropping practically all flat-rate loads and getting such customers as would do so (perhaps 40 per cent. of the total) to come back on meters, stating that the shrinkage in fuel consumption alone would more than make up for the loss of income.

Mr. T. F. Grover cited the case of a plant in Fond du Lac, where less than three years ago every load was on contract, the compulsory use of meters driving away about ten of the customers. In spite of this, the business has increased from 3300 to 6500 lights, with an addition of only 400-light capacity in transformers. The business of the plant has been practically doubled, and the ampere output of the station is less than it was under the old conditions. The discussion of minimum charges brought out the fact that $1 per month was the smallest rate that a company could afford to give.

Mr. A. J. Rogers was then introduced, and read a paper on the subject of "Electricity Direct from Coal."

The meeting then adjourned.

PROCEEDINGS OF MORNING SESSION, JANUARY 19.

The committee appointed the previous day to nominate candidates for officers of the association for the ensuing year, and for other business, then made its report. The nominations were as follows: President, Henry L. Doherty, of Madison; first vice-president, John H. Harding, of La Porte, Ind.; second vice-president, S. B. Livermore, Winona, Minn.; secretary and treasurer, Thomas R. Mercein, Milwaukee; and Messrs. Col. W. W. Bean, St. Joseph, Mich.; J. H. Culver, Decatur, Ill.; George Innes, Eagle Grove, Ia., board of directors. The committee's further report recommended that the salary of the secretary and treasurer be raised from $150 to $300 per annum; that the association hold no summer meeting in 1899; that there be created an information committee, consisting of the secretary, Messrs. P. H. Korst, of Racine, and E. L. Debell, of Sheboygan; that the matter of representation at State capitals be left with the president, secretary and protective committee, who should also have power to act upon the various resolutions introduced on the question of legislation, and to raise funds for defraying expenses involved in such work. The committee also recommended that the annual dues remain at $5 per year.

The officers as nominated were elected by a unanimous ballot.

A paper was then read by Prof. D. C. Jackson on the subject of "Inductive Loads on Alternating-Current Transformers," an abstract of which will appear later in these columns. In the discussion Mr. W. S. Schott described tests of alternating arc lamps on a 100-light transformer, with a frequency of 133 cycles. With the lamps and transformers first tested it was found that there was about a 7-volt drop per lamp, which was finally brought down to 1½ volts, with a proper choice of transformers.

Mr. Geo. L. Thayer then read a paper on the subject of "Design of Secondary Circuits in Alternating Plants." The discussion brought out the importance of running back pilot wires from the secondaries of alternating-current systems to give good regulation at the lamps, especially when arc lamps are used, rendering the load inductive. After further discussion the convention adjourned.

PROCEEDINGS OF AFTERNOON SESSION, JANUARY 19.

The purpose of the committee of information was explained, after which a paper by H. M. Maxim, of Hartford, Conn., was read on the subject of "Electric Vehicles and Their Relation to Central Stations." A paper was also read by Mr. J. H. Harding, of La Porte, Ind., on "The Utilization of Exhaust Steam." Abstracts of these papers may be found on other pages. The latter paper elicited a discussion showing great interest in the subject, further details being called for and given, as abstracted with the reprint of the paper.

The regulation of temperature in houses supplied with hot water from exhaust steam heaters was discussed by Mr. Stahl, who advised the installation of an air compressor at the central station and the laying of a small third pipe to all houses taking hot water to convey compressed air for the supply of thermostatic valves, in which case the temperature of the water in the mains can be varied considerably and the mains used as a thermal storage tank without affecting the proper uniformity of the heat delivered. The cost of the mains was estimated at about one-third of those with the same capacity for steam distribution, the cost of the interior piping for a typical eight-room house with 600 square feet of radiating surface, at 30 cents a foot, being estimated at $180, with a further charge of $20 for the thermostat and $25 for the service connection. The rates for heating quoted by Mr. Stahl were 12½ cents per square foot of radiating surface per season, which would amount to about $75 for the residence assumed, or less than that of coal in most cases.

President Doherty brought forward for action several amendments to the by-laws; one of these leaving the choice of the location of the annual meeting to the directors, instead of limiting it to Milwaukee; another giving the directors the right to reclassify the members of the association; another calling for the nomination of honorary members at least six months prior to their election; another making the election of officers the closing order of business; another providing for an association button. These amendments were referred to a committee. Mr. E. L. Debell was appointed to edit the proceedings to eliminate any features that the association might not desire to have appear in print. The president also suggested greater activity in the bringing in of new members, and the attendance at conventions, which would encourage supply men and exhibitors and draw further attendance.

The meeting then adjourned.

PROCEEDINGS OF SESSION HELD JANUARY 20.

Mr. Thomas R. Mercein was appointed by the president as a delegate to attend the convention of the National Electric Light Association, and Messrs. D. C. Jackson, L. E. Kerns and L. W. Burch were appointed as a committee on badge and proposed amendments to by-laws.

The convention then adjourned.

THE NEW PRESIDENT OF THE ASSOCIATION.

Mr. Henry L. Doherty, the new president of the Northwestern Electrical Association, is one of the live young men whose influence toward the revivifying of central stations working languidly on old lines has been felt in many widely scattered cities of the West. Mr. Doherty inherits his engineering bent from his father, who was a hydraulic engineer and inventor. He was born in 1870, in Indiana, and spent his boyhood days in Columbus, Ohio. For sixteen years he has been connected with the banker, Emerson McMillin, in connection with the wide gas and electric light interests of the house of Emerson McMillin & Co. Since the spring of 1896 Mr. Doherty has been officially connected with the Madison Gas & Electric Company as general manager, and has to a certain extent made his home in Madison, Wis., although a great deal of his time is spent in New York city in the performance of his duties as engineer and adviser of Mr. McMillin. His experience, while chiefly in the gas business, has been quite comprehensive, including mining and hydraulic engineering work, as well as a large amount of work in the electrical line, with the advance of the various branches of which he has kept in remarkably intimate touch considering the range of his business career.

HENRY L. DOHERTY.

The Lighting of the Rock at Gibraltar.

An electric lighting plant has been installed at Gibraltar carrying over 3000 lights in the military and civil government buildings in and around the great rock.

Electric Vehicles and Their Relation to Central Stations.*

BY H. M. MAXIM.

The rapid advance being made by the electric motor wagon directs the attention of those interested in central-station matters to the probable effect of this new industry upon central-station affairs. An investigation has been made into the question, and it is thought that the results stated as briefly as possible may be of some interest at this time.

The battery is, of course, the prime consideration in an electric automobile. The conditions to which a storage battery is subjected in this service are probably as severe as any existing, and it is only recently that battery manufacturers have given due attention to the production of a type of cell specially suited to this work. The prime conditions to be fulfilled are evidently lightness and compactness, but in addition to these must be added ability to regularly withstand heavy currents of charge and discharge without buckling or disintegration, and general durability to offset the mild abuse which, under the present conditions of popular knowledge respecting the storage batteries, seems inseparable from its general and indiscriminate use by the public.

The type of battery giving the greatest capacity per pound, apart from other considerations, is probably found in some form of pasted cell, and the future battery for motor carriage work is quite likely to be a high capacity, durable cell of this type; but there are objections to all existing forms of pasted cells on the score of delicacy and short life, and the Pope Manufacturing Company and the foremost American makers, after testing the principal types both here and abroad, have almost universally adopted a combination type of cell as nearly fulfilling the requirements.

The present state of the art requires that a cell, in order to be of any value, should show a capacity of from 3.5 to 4 ampere hours per pound of cell complete with lugs, jar, etc., at a discharge rate of not less than 1.3 amperes per pound of complete cell. It must, furthermore, be possible during discharge to increase this rate to 4 or 5 amperes per pound of cell for short periods, without injury, and to charge it from empty to full in three hours, or thereabouts. With a battery coming up to these specifications, a mileage of thirty-five can be obtained under favorable road conditions with an electric phaeton seating two people before the point of injurious exhaustion has been approached. This performance can be, and has been, greatly surpassed by the use of high capacity cells of short life, and a run of 92 miles is actually reported from Paris, but this practice is generally condemned by American engineers as removing the electric carriage too far from the field of practical utility by the use of a battery incapable of rough usage and economically useless through its short life. In France several firms are engaged in the business of letting out or caring for vehicles fitted with high capacity batteries, the great demand for which enables them to charge such rates as to realize adequate profits in spite of the frequent renewals of the short life cells. The conditions which admit of this practice are plainly of a temporary nature, and American builders have, we believe, with good reason, refused to lose sight of the practical features of this question for any mere considerations of temporary profit.

The usual American practice is to equip a vehicle with forty-four cells in rubber jars, four groups being formed by boxing together eleven cells. This makes a combination which can be charged from a 110-volt circuit, and three speeds can be obtained by merely changing the grouping of the boxes and the consequent voltage applied at the motor terminals. Thus, with all four groups in multiple at a reasonable discharge rate approximately 22 volts are obtained, two in multiple and two in series gives 44 volts and double the speed, while with all in series the full voltage of the battery is reached. The combinations of resistances and alterations in the field connections of the motors can, of course, be used for further speed variation, but many of the best types of carriages find the simple changes in the cell groupings ample for all purposes, a manipulation of the controller lever and the increasing and diminishing momentum of the carriage affording numberless gradations of speed once thought obtainable only through a large number of controller steps.

Series motors are in general use, employment sometimes being made on the same carriage of two motors mechanically separate, but series connected, each geared to its own driving wheel. In this way an electrical balance of the driving power is obtained between the driving wheels, and the alternative of a mechanical balance is obviated. Experience has shown this, however, to be an advantage only in special cases.

Let us take for discussion a single-seated Columbia phaeton, as this represents a common type, is built by a well-known firm, and may fairly be regarded as the standard of the day in its own field. This carriage complete weighs approximately 2000 pounds, 45 per cent. of which is due to the battery. The controlling apparatus consists of a foot lever connected to a band brake, a steering lever at the driver's right hand, the controlling lever at his left, a push button for an electric signal bell in the controller handle and a foot reversing lever used only preliminary to backing. This carriage is at all times under the perfect control of the driver, can be turned in a 26-foot circle, and can be stopped on the level when going at a rate of ten miles per hour within twenty-five feet from the point of application of the brake, if the occasion demands, ignoring the wear upon the tires. It can be operated with ease by persons without previous experience, a woman's strength is, and frequently has been, sufficient to completely control it, and for the average individual but a few hours' trial is necessary to give skill and familiarity in all phases of its operation. Its simplicity and flexibility is a very good illustration of what can be done with electricity when properly applied to a vehicle.

The batteries can be charged inside the vehicle when the service demands it. To this end each carriage is provided with a flexible conducting cable to connect with the source of supply, terminating in plugs of different diameters. These plugs fit into corresponding receptacles at the rear of the carriage, and in no way can a mistake be made in inserting them owing to the difference in size. Better care can, of course, be given the batteries when removed and exposed to the view of the attendant, and this is ordinarily done when possible.

The battery is placed upon the 110-volt circuit with the interposition of a sufficient resistance to bring the current down to 40 amperes for this particular type, at which point it is maintained until the voltage has risen to 110, when the current is allowed to diminish until it has reached but a few amperes. This method completes the charge from empty to full in three hours. Automatic features for cutting out the battery when full have been introduced with success by combining a recording wattmeter with a cut-out magnet. This wattmeter registers the watt hours of discharge by a movement of the pointer in one direction, while the charge is recorded by an opposite movement of the pointer, each scale division on the return movement, however, corresponding to a sufficiently increased number of watt hours to adequately provide for the average internal loss in the batteries, so that when the zero or full position of the scale is reached on charge the batteries are again in a fully charged condition, and a contact is made which operates the cut-out. As popular knowledge respecting storage batteries increases, however, it is probable that devices of this nature will be eliminated for the sake of simplification, and used only occasionally; for it is found that a little familiarity with the subject enables one to form a most accurate estimate from mere observation as to when the fully charged condition has been reached by a battery.

As regards discharge, one's senses soon become so trained that a very accurate determination of the voltage, and hence the condition of the batteries, can be made by noting the diminishing speed of the carriage, slight as it is. The capacity and the general working of a storage battery are more or less modified by conditions of temperature, etc., due allowance for which cannot be made by any recording instrument, and one's observation becomes after a little experience the simplest and most complete battery indicator.

It has been found by experience that the average coachman or caretaker, after a week's instruction, is competent to care for an electric carriage. With the exception of the batteries, the attention required is no more than that necessary for an ordinary horse vehicle, and no more complicated than that given a bicycle, and the mere routine of charging the batteries and maintaining the electrolyte at the proper specific gravity is soon learned.

When we come to the application of electricity to the delivery business, it might seem at first as if a vehicle reaching its limit of continuous mileage in the thirties were laboring at a disadvantage. This is not the case. An investigation of the daily mileage of the busiest delivery wagons of some of the largest houses shows that rarely does a wagon accomplish 18 miles on a single trip, and that a considerable interval invariably elapses between trips. Thus, not only is the mileage sufficient, but delivery wagons built for light goods delivery are at present designed for a maximum mileage of 25, thereby gaining decreased battery weight. The interval elapsing

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between trips is utilized to charge the batteries in the wagon, which requires approximately two hours, for they are but partially exhausted. An excellent example of the advantages of this class of services is shown by an electric mail van used by the post-office authorities in London. This van makes six trips per day between the main and branch office, a total mileage of 40, with one set of batteries. On each trip it carries about 1200 pounds of mail matter. Actual tests of the power consumption of the heavier class of electric vehicles show that 65 watt hours per 1000 pounds per mile at a sped of 10.5 miles per hour is a conservative estimate, in fact, probably rather high, as these figures were obtained over suburban roads, and not on hard pavements. The expenditure necessary to recuperate the batteries may be liberally estimated at 100 watt hours per 1000 pounds per mile.

The following delivery wagon actually built, a good example of the dry goods type, may be considered in this connection: Total weight, loaded, 4500 pounds, including weight of two drivers and 1000 pounds of useful load; maximum mileage, 25; weight of batteries, 1300 pounds. From the above considerations the expense of running this wagon on a 15-mile trip would be the cost of 6.75 kilowatt hours, and 13.5 kilowatt hours for two trips. From figures obtained from prominent retailers in the large Eastern cities, it appears that the cost of stabling one delivery horse at the owner's stable, cost of shoeing and repairs for harness, amount to $250 per year, and as an electric delivery wagon can be run continuously save for short intervals of recuperation, and can therefore do the work of two horses, double this amount, or $500 per year, is the expenditure for the operation of equivalent horse service. On a basis of two trips per day for the electric wagon, the yearly expense of operation, allowing 300 working days to the year, is that of 4050 kilowatt hours. Any reasonable price for power leaves a considerable margin in favor of the electric carriage.

The custom of the large retailers is to despatch fresh deliveries at frequent intervals. These are divided into several classes: some go to the extreme range of distance, others go but a few miles, and returning quickly make a large number of trips during the day. Starting in the morning, then, with the batteries fresh, no charging current would be required until the first short trip had been finished, when each battery as it is connected to the charging mains would take 50 amperes. This current would soon diminish for a single battery, but as the separate sets would be connected in and cut out from this time on, a fairly constant load could be expected until midday, when there would probably be more or less of a peak. This would be followed by an afternoon load and another peak at the close of the day. This, of course, is merely a general supposition as to the power consumption of one large concern. The use of electric wagons by a large number of smaller concerns operating under different programmes—a situation which the majority of central stations is more likely to meet—ought to effect a day load approximating a fair degree of constancy.

The operation of a cab or omnibus system would work to even greater advantage to the central station. An omnibus system planned for one of our central cities provides for nine vehicles, each carrying twelve persons and running under a headway of five minutes. The route to be traversed will necessitate the expenditure of about one-half the charge of the battery, so that each set can be brought to the full condition in two hours or less. This would, of course, necessitate a change of battery for each trip, and, when running on a five-minute schedule, a total of twenty-four sets of batteries constantly on the line. At the end of every five minutes a set would be cut out and a new one put on in its place. This would cause a load of approximately 930 amperes, diminishing to 880 at the end of five minutes, when it would again rise to the maximum.

The demand for omnibus service in many places, especially in certain localities where for æsthetic reasons the trolley lines are excluded, is without doubt a real one, and will within the next twelve months call for the equipment of many such lines. The success in many instances must rest in a measure upon the co-operation which the central-station owners afford, and it would seem that the desirability of increasing the day consumption of power and the ultimate immensity of this demand would invite their most favorable attention. The consumption of day loads by electric vehicles offers such manifest advantages that the lowest possible rate should be made this class of customers for the encouragement of the industry and from considerations of its coming importance. Prices for charging current for storage batteries vary over a considerable range, partly on account of the differing conditions of day load in different localities, but mainly owing to the novelty of the service, which would necessarily tend to make the price uncertain, but as an indication of what can be accomplished one of our largest cities considers the day load which is gained by this service to fully warrant it in offering current at two and one-half cents per kilowatt hour, of course in reasonable quantities.

An important aid in popularizing the electric motor vehicle would be rendered by central-station owners were they to provide their plants with the apparatus necessary to charge a carriage, and thereby invite public confidence in the existence of charging facilities at all stations, thus relieving the technically uninformed man of much anxiety and care when he is obliged to cover unknown territory with his vehicle. Quite an important and novel feature in this connection is the use which will shortly be made in New York, and will be capable of indefinite extension, of a so-called charging "hydrant." This is now being perfected by a prominent electric company, and consists of a coin-controlled mechanism with a wattmeter, voltmeter, rheostat, switch and terminals, such that the driver of an electric vehicle, after having deposited the necessary coin in a slot, can draw upon it for a certain number of watt hours. The general adoption of some such device as this, and the certainty of finding it in different localities of a city, would greatly encourage the general use of electric automobiles.

The smaller plants within twenty-five or thirty miles of each other will feel the influence of the pleasure carriage and regularly established touring routes will soon be a fact through those localities where the lighting stations have had foresight to provide themselves with facilities for charging. Many central-station managers have needed no light to point them the way. The station of the Central Railway and Electric Company, at New Britain, Conn., provided itself with facilities for charging itinerant electric vehicles nearly two years ago. In alternating plants, if possible, means should be provided for obtaining direct current from some other source than the exciters—either a direct-current machine or a rotary transformer. A small recording wattmeter would be found a valuable adjunct, while a voltmeter, small rheostat, switch and charging leads would comprise the list of essentials.

After all, we are mainly interested in the appearance of the ledger. The greatest financial problem which has confronted the managers of central stations has been the relation between the cost of installation and the return thereon, which must be secured during a very small portion of the hours of the day. This makes the cost of horsepower per annum very high when investment charges are considered, and even those most unfamiliar with the problems confronting the central station managers nevertheless have at least a vague familiarity with the question of the search for a day load. The new and strenuous demand for motor carriages seems to us to furnish the key to the situation, and the small cost in trouble and money which the central-station manager need give in encouraging this demand will amount to nothing as compared with the certain return which in many localities can be even now supported by the figures.

It does not seem to me to be an exaggeration to say that the horseless carriage builder now offers the solution of this vexed problem.

A New Construction of Electrical Rheostats.

A distinctly novel type of enamel rheostats is described in United States patent No. 617,375, issued January 10, 1899, to J. F. H. Voight and J. A. Haeffner. The construction consists of a thin layer of liquid metal applied by means of a firing process—after the manner in which lustrous gold, silver, or platinum decorations are applied—to an enamel layer on a suitable base-plate. This thin layer contains the metal in a very finely divided state. It can be applied in solution, being painted on after the manner of applying the well-known "metalliferous lusters" or "liquid-bright metal colors" on enamel layers, the metal being afterward brought out by a firing process. These "metalliferous lusters" or "liquid-bright metal colors" are solutions of organic compounds of metals or precious metals—such as, for instance, sulfid of gold combined with balsam of sulfur or mixtures of the same in organic dissolvents, such as nitrobenzine, with or without the addition of essential oils. These solutions may contain compounds of bismuth, boric acid, of phosphoric acid as combination of flux.

This thin metal layer may be applied in zig-zag or sinuous strips or spirally to a flat enamel surface, or arranged helically on a cylinder, or in any desired way. A sliding contact may, of course, be obtained with it at any point. Its use as a fuse is also proposed.

Design of Secondary Circuits in Alternating Plants.*

BY GEO. L. THAYER.

The electrical press and the transactions of the various electrical societies have from time to time contained papers on the desirability of large transformers. I shall endeavor to lay before you the details of what is becoming standard practice in this respect. If we each of us had to begin over again it would be very easy to arrange our distribution system so as to get very much better results. It is a different matter with the greater number of alternating-current stations. Thousands of dollars of equipment cannot be thrown away, but by a little forethought in connection with the changes resulting from the growth of the business a good start can be made toward improving the regulation and cutting down the iron losses. Of the several conditions peculiar to alternating currents, capacity and skin effect will be neglected. Capacity is only of importance in long-distance transmission work, which is outside of the limits of this paper. The influence of skin effect is so very slight, not exceeding 2 per cent. in 0000 copper at 125 cycles, and less in smaller sizes, that it may be neglected.

The line of improvement must lie in the direction of better regulation and increased efficiency of distribution. This leads naturally to an increase in the voltage of the distributing circuits. 220-volt lamps, with their 4-watts efficiency, are out of the question in their present state. To-day the system of distribution that has been brought to the highest state of perfection is the Edison three-wire.

A discussion of why alternating practice avoided the three-wire system of distribution is principally a question of patents, which, although interesting as a matter of history, is outside the range of this paper. It is nothing against the usefulness of alternating currents to take up the methods so successfully followed by the Edison stations for fifteen years. This means a more or less extensive three-wire network, with the transformers and their primaries regarded simply as feeders. In the heavy lighting districts and the residence parts of the town it would be the aim to design a system of mains which should in time form an interconnected network. In the partially developed districts it would be desirable to have the larger transformers feed into the network by means of tie lines carrying 220 volts. Where the two sides are well balanced, the neutral on tie lines can be omitted. The conditions, however, are somewhat different from those encountered in direct-current work. In direct-current stations the drop in feeders is usually 10 per cent. and in mains 2 per cent., while in alternating-current stations the feeders which are the transformers and their primaries have a drop of from 2 per cent. to 8 per cent., the latter where the motor load is heavy. In general it will not exceed 4 per cent. This means that with a concentration of load in one portion of the network the drop in voltage will be greater with direct than with alternating currents. The more variable the load, the more useful is the inter-connection of the mains supplied by different transformers. In the case of transformers supplying a lighting load whose maximum is fairly uniform the year round, as in the case of the business districts in the smaller towns, the advantages of tying in the mains is not as great. It is, however, very desirable to tie the business with the outlying districts with those that are not so uniformly loaded. Week nights the heaviest load is down town. Sunday nights the stores are not running and the residences are using more lights than during the rest of the week. In this way a given transformer capacity will serve more lights. The regulation is also improved, but of this I will touch later.

As to voltage, 52-volt secondaries should be abandoned in new work, and 104 or 110-volt with or without a three-wire system should be used. In point of fact, 52 volts is suitable only for house-to-house transformer distribution. The lamps will stand extremes of voltage better than the 110-volt lamp. But with the improved regulation possible with 110 volts a better lamp life can be obtained. To take a concrete case, the transformer being located on the street corner, with 52 volts and with a given amount of copper and a fixed drop current can be transmitted half the length of the block in four directions, serving an area the equivalent of one block; with 110 volts two-wire, four blocks can be supplied; with 110 volts, three-wire, the neutral being the same size as the other two wires, ten blocks can be supplied. In addition to the reduction in iron core losses the regulation is improved as the load is more uniform. In the lighter loaded district the drop in the mains is an advantage, as the voltage has to be carried to suit the heavier loaded districts. The pressure is more apt to be high rather than low in the residence and lighter loaded districts. When residences are on meter the transformer capacity need not be in some cases more than 25 to 33 per cent. of the total connected load.

The efficiency of the lamp generally used in alternating work is 3.6 watts. In order to use a 3.1-watt lamp the regulation must be brought to within 2 per cent., the standard in direct-current work. The obstacle to this is not the station regulation, but is due to the fact that, while some transformers are fully or very commonly overloaded, others near-by are running under a very light load. It is no unusual thing to find adjacent buildings where the difference in pressure amounts to 4 or 5 per cent. As the voltage is carried so as to give the lowest points somewhere near their proper voltage because of complaints from customers, the general run of pressure on the plant will be too high rather than too low. The first step is to reduce the extremes of load and bring about a more uniform condition of load and drop in the transformers and mains. Large transformers and the tying together of light and fully loaded transformers, with sufficient copper in the distributing mains are the remedies. But to do this effectively without excessive copper cost a three-wire system is practically necessary. To illustrate: Two transformers are 500 feet apart, one of which is connected to a hall requiring at times fifty to seventy-five lights. These are tied together with two No. 4 wires, costing $25. If the voltage on the mains near the hall should be lowered, due to lights being used in that building, current sufficient for thirty lights would be furnished by the other transformer. With the ordinary two-wire mains at 110 volts but eight lights would be furnished, unless the copper cost were increased to $100. These tie wires would increase the capacity of the two transformers to supply lights by an amount sufficient to fully offset their cost, leaving you ahead in the matter of regulation. On these tie lines the neutral wire can be as small as No. 8, or may even be omitted.

The calculation of drop in the voltage at the lamps differs from that of direct-current work in the addition of the inductive resistance in the lines and in motors. The subject has rarely been published in a form suitable for the station manager who does not desire to wade into mathematics. As long as lamps form the only load, the line losses do not differ appreciably from what they would be with direct currents. If a portion of the load is in small motors whose power factors do not exceed 80 per cent., the inductive drop in the lines begins to assume importance. With a power factor of 95 per cent. the drop is increased 50 per cent. with No. 1 copper at 125 cycles and No. 000 at 60 cycles, the lines being about 18 inches apart. The lower the power factor the poorer also is the regulation of the secondaries. The inductive effects can be kept down by sub-dividing the heavy circuits, bringing the wires closer together, using lower frequencies, and by operating motors with good power factors. Although the inductive effects decrease quite rapidly when the conductors are brought within 12 inches, it is hardly practicable to make the distance less than this on overhead work. On the underground work at St. Louis the effects of induction are very small. Beyond 36 inches the increase in inductive effects is not very great.

The distance to which secondaries should be extended depends upon the density of the load in the district. In general the more scattered the load the further it will pay to run from the transformer. It is impossible to give any hard and fast rule. The prospects for future growth of the business will have some bearing upon it. In the residence districts 1000 feet is about the limit. In the business district about 500 feet will be found the most satisfactory radius of supply, the chief reason for this being that the gain in efficiency with increased size is not as great in large as in small transformers. At 500 feet radius one block and at 1000 feet four blocks can be supplied from one transformer. This will bring the transformers from 1000 to 2000 feet apart. These may seem long distances, but it should be remembered that with a given weight of copper distances can be almost doubled on a three-wire distribution. The ultimate location and size of the transformers will be influenced largely by the way in which the load in the particular district has been developed. On my own plant in the residence districts, which seem to be the home of the small transformer, I figure on a transformer supplying all the lights within a radius of 1000 feet or two blocks in each direction, the transformers being located preferably at the street intersections. The secondaries are mostly No. 4 and No. 6 copper. With the load distributed uniformly along the wires a maximum of 60 lights can be carried in one direction from the transformer with a 2 per cent. drop. From all four di-

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rections a total of 250 lights can be carried with no run exceeding 2 per cent. drop. If the load becomes too heavy a tie line is run to the nearest large transformer, unless that transformer should be fully loaded. If this cannot be done a larger transformer is installed. In the case of a customer a little beyond 1000 feet, unless his maximum demand is less than two or three lights a separate transformer is installed, until such a time that additional business can be secured in that vicinity. The transformers used are from eighty to one hundred lights capacity. I would say in this connection that a great deal of our residence lighting comes from houses not using more than three or four lights at a time, a condition favorable for the maintenance of a good balance of the three-wire secondaries.

It is possible to use transformers too large for the most economical results. There is a point different on every station at which the interest and depreciation on the copper is greater than the saving in core losses. The conditions on a station running six or seven hours is radically different from that of a station operating twenty-four hours. The core losses are four times greater in the latter, while the copper costs remain the same. The number of watts per pound of coal is another factor. In general, the longer the run the larger the transformers which should be used. As regards the core losses there has been a tendency on the part of manufacturers to exaggerate their cost. It is a common practice to estimate them at 4 or 5 cents per kilowatt hour. It is a poor plant whose fuel cost over 2 cents, unless coal is high. In a station, running under economical conditions, the fuel will not exceed 1 cent under favorable conditions. Unfortunately the stations that have the heavy core losses are the very ones whose fuel cost per unit of output is the highest.

Hardly secondary to that of low core losses is the question of good regulation. Upon this depends the quality of service given the consumer. You are all familiar with the complaints of dim lights where a period of normal voltage alternates with a short period of high pressure. If an even voltage can be maintained better satisfaction will be given, even when the mean voltage is 1 or 2 per cent. lower. With small transformers unequally loaded the primary pressure cannot be regulated to suit the come and go of the load on all of them. Some lights are habitually subjected to an excess of voltage, others are equally low, and still others bright during one portion of the evening and dim at others. The importance of good regulation can hardly be overestimated. An excess of 2 per cent. in voltage will shorten the life of a 3.1-watt lamp one-third, besides causing a more rapid deterioration in candle power. A 3.6-watt lamp is the lamp most commonly used on alternating stations. Not only does this lamp take 15 per cent. more current, but the difference is all the greater because with poor regulation the tendency is to try to help matters by raising the pressure at the stations so as to bring the low lamps up to voltages. For a short time matters are improved, but the lamps are overstrained, and either burn out or else fall off in candle power.

The 3.1-watt lamps have been used for some ten years on Edison stations. There is no reason why they should not come into much more general use on alternating work. To do this the system of distribution must be improved. Any method by which the transformers are uniformly loaded will accomplish this result, provided, of course, that sufficient copper is used between the transformer and the consumer to keep the drop within reasonable limits. In fact, owing to the flexibility of alternating currents, as good results can be obtained with less expense than in the case of direct currents, where the load is a mile of so from the station. In the districts where the lighting is scattered, house-to-house transformers must be used, and the results cannot be made as good. The ordinary methods with the 3.6-watt lamp must still be used. Sometimes conditions are such that a 3.1 lamp can still be used, but of a slightly higher voltage.

Most stations take the pressure for the switchboard voltmeters from the primary mains, where they leave the building. As the load comes on the pressure is raised. With small transformers this is about the only way of doing, for there is no place at which the pressure can be taken as a standard. Then again the expense of the pressure wires is sometimes very heavy, owing to the distance of the load from the station. Where there is a secondary network it is very much better to run pressure wires back to the station, even if the distance is a mile or two. If there is no network the pressure should be taken from some large transformer whose load corresponds closely to the general conditions on that circuit. A great many station voltmeters have a large temperature coefficient, sufficient to make a difference of 2 or 3 per cent. between winter and summer. Some are affected slightly by the change in frequency.

On account of the additional element of induction a departure from direct-current practice is advisable in the arrangement of the secondaries on the cross-arms. The distance between conductors cuts but little figure where the load comes from lamps only. Where the power factor is 95 per cent. or less it is a distinct gain to have the conductors as close together as is practicable. All central stations ought to look forward to the time when they can obtain a power load. Because it is not now possible is no reason why it never will be. As it entails no extra expense, it is better to arrange for it when changes are made from time to time. Bringing the conductors closer together reduces the effects of induction. Accordingly bring the wires corresponding to the + and − in three-wire direct-current work together and leave the neutral outside. As the neutral carries only the unbalanced load, which is a lamp load, its power factor will be practically 100 per cent. The motors will take current at 220 volts. On a four-pin arm the neutral is placed on one of the outside pins, the other two next to the pole.

What will be the effect of a change of frequency on the transformers and secondaries? The transformer data sent out by several of the large manufacturing firms are familiar to everyone. At 125 cycles the iron losses are in general 25 per cent. less, while the regulation falls off about the same amount. The regulation on the lines is about the same at both frequencies. This is in case of a lighting load only. With a motor load, with its lower power factor at either frequency, the drop is very much increased in the transformer. A transformer having a drop of 2 per cent. on a lighting load will have 5 to 8 per cent. on a motor load. On the secondaries the drop is greater at the higher frequency, especially on the larger sizes of wire. At 95 per cent. power factor and 24 inches centre to centre of the conductors, at 125 cycles No. 0 gives the same drop as No. 0000 at 60 cycles. With the smaller conductors the differences are not so great. If you intend to run only small motors or arc lights from the lighting mains do not use 60 cycles, unless there is a good reason for so doing.

For a lighting load only 125 cycles is perhaps the better frequency. But where both lights and motors are to be supplied it is better if the way can be found to change to 60 cycles. In the fair-sized towns heavy wires must be used on the secondaries, and it is important to keep down the inductive effects.

While the arrangement and sizes of transformers in alternating plants has improved very much in the last few years, there is room for further progress. Most of us would like to have the building of our plant to do over again. The next best thing is to build our extensions in the best manner possible. Theoretically it may pay to throw out a great many transformers. Practically one-half of that number will not be discarded, unless the owners have idle capital awaiting investment. Most of the transformers built previous to 1892 it will pay to replace. The later types are a marked improvement over the earlier. The first step to take is to stop buying any more small transformers. You have probably enough of them to last a good many years. The increase of business can be taken care of by large transformers with three-wire secondaries. This will displace a great many small transformers, which will become available where a house-to-house distribution is the only practical method of lighting. Make arrangements to discard little by little the use of 52-volt lamps. A place can usually be found for the 52-volt wattmeters. It will probably be found that the beginnings on the three-wire secondaries can be first made in the residence districts, as many stations are fairly well equipped with large transformers in the business districts. It is not necessary to begin by throwing out small transformers. Wait until it is necessary to buy more transformers. Then get a large transformer which will replace several small ones. The number of small transformers can be reduced by making one transformer supply two or more houses. Don't be afraid of an occasional overload. It does not come often, and then in the wintertime, when, because of the low temperature, the transformer can best stand an overload. Figure on the average load, not the exceptional. Regard the installation of a transformer smaller than 25-light a temporary move.

As an illustration of what can be done in the line of installing large transformers in residence districts, the following example will serve: In an area one block wide and four blocks long there were some three years ago fifteen houses and one small church, with a total of 200 lights connected. It was supplied by the following

transformers: One 65-light, one 40-light, two 25-light, two 15-light and two 10-light, a total capacity of 205 lights. The core loss was 680 watts. In modern types these transformers would cost $205. They were replaced by a 120-light, three-wire transformer, with a core loss of 78 watts and 2 per cent. regulation, costing $99. Secondaries were put in at an expense of $125, a total of $225. The same district now contains nineteen houses and one church, with a connected load of 350 lights, about equally divided between meter and contract. In addition a tie line of two No. 4 and one No. 6 wires taps the corner of the business district 450 feet distant, supplying a portion of the load from an opera house and the downtown secondary network. A 40 or 50-light transformer is thereby saved. The regulating effect of the tie is shown from the fact that the voltage in the houses is within 1 per cent. of the adjacent business district; 3.1-watt lamps are now used where 3.6-watts were used, and with as good results.

The question of polyphase systems has been omitted entirely. A discussion of them would be beyond the limits of this paper. Whatever the system adopted where power is not the principal business, and it is desirable to run 1 and 2 hp motors from the lighting mains, the three-wire secondaries will need but the addition of a fourth wire in the polyphase systems, and none at all if single-phase motors are used. The entire question has been treated from the standpoint of the smaller station, as they comprise the majority of the stations represented here.

The alternating current is essentially a pioneer. It affords the only means of lighting the scattered districts where the cost of direct-current mains would be prohibitive. The early apparatus was far behind the direct-current machinery of that day, but with the improvements of late years, coupled with its wonderful flexibility, it occupies a field that cannot be entered by the direct current.

Utilization of Exhaust Steam.*

BY J. H. HARDING.

All who have given thought to the many practical economies possible to be practiced in connection with an electric plant have figured more or less upon the utilization of the heat going to waste in the exhaust steam. No careful man would think of pumping feed-water into boilers without first passing it through a heater. I know of but one large plant (now in the hands of a receiver) that uses an injector to force water into the boilers direct from a cold well, using no heater and running non-condensing.

As only a small per cent. of the heat contained in the exhaust steam can be used to heat the feed-water, the question naturally arises whether the balance of it can be utilized. If so, how to the best advantage? In looking for a means of utilizing the surplus, we find several systems being promoted for heating by exhaust steam. Personally, I have had little knowledge of heating buildings with exhaust steam at either near or distant points from a central station. My inquiries along that line led me to the conclusion, however, that while some plants were reasonably satisfactory others were giving much trouble. The reports indicated that as the load and distance increased, the trouble also increased. Another objectionable feature was the great expense of construction. An economy or saving is of advantage only when it can be utilized without too great an outlay of capital. While investigating, we heard of a system in which the heat of the steam was transferred to a volume of water, and that, being circulated through a supply and return pipe, delivered the heat to the buildings to be heated. After a careful investigation of the Yaryan system, as it is called, the La Porte Electric Company, of which I am superintendent and manager, concluded to install it at La Porte in 1897.

We find that it is possible to heat buildings within a mile of the station, thus giving a large field to draw custom from, permitting us to go to the residence district, and not to be confined to the business section only. This has been a good thing for us, for, while we have our mains in the alley behind seven blocks of business houses, our income is less than 20 per cent. from that source.

We have a line running one mile out through the residence part of the city, nine residences being heated, located within one block of the end.

Again, our station being located at the highest point in the city made it difficult to return the condensed water from steam mains. With this system it makes no difference; both lines being full of water, one balances the other, making it possible to supply heat above or below the station.

One of the strongest features in favor of the system is that as the water is returned to the station after it has passed through the buildings to be heated it suffers no waste of heat, except the amount radiated from the pipe line and that sold to the customer. That is to say, that if we send out water at 160 degrees, the return would be 130 degrees, so by raising the water 30 degrees, it is up to 160 degrees, and ready to go through the line again. The difference in the amount of heat that would be lost by radiation from the mains, whether they were of an average temperature of 220 degrees, as with steam, or only 160 degrees, as with water, was an important item that we took into consideration.

There are many features of economy connected with the system that will appeal to the central-station man when brought to his attention that would seem too much like an advertisement were I to introduce them here. Suffice it to say, we are satisfied we have a practical way of utilizing all of the exhaust steam at our station.

*Paper presented before the Northwestern Electrical Association, Milwaukee, January, 1899.

Convention Notes.

MESSRS. POMEROY & McGILL, of Chicago, were in attendance and kept very busy during the entire convention.

THE PERKINS ELECTRIC SWITCH MANUFACTURING COMPANY, Hartford, Conn., was represented by Mr. E. K. Patton, its Chicago manager.

MR. RUSSELL A. WILSON, of Marquette, Mich., was a unique attendant. He was the only representative at the convention of a municipal electric plant.

THE WALLACE ELECTRIC COMPANY, Chicago, was represented by Mr. E. L. Barr, selling agent for the Chicago arc lamp. Mr. Barr claims that this lamp is the best for direct current.

THE CLOOS ELECTRICAL ENGINEERING COMPANY, Milwaukee, Wis., had the merits of its oil break switches for high-voltage circuits well presented to the delegates by Mr. H. R. King.

THE CHICAGO INSULATED WIRE COMPANY, Chicago, was well represented by Mr. William M. Smith, who is not only a convention favorite but knows the trade from the Atlantic to the Pacific.

THE COLUMBIA INCANDESCENT LAMP COMPANY, St. Louis, Mo., was well represented by Mr. George P. Rex, acting secretary, who distributed a very handsome catalogue describing and illustrating Columbia lamps.

MR. GEORGE S. WHYTE, secretary of the Leschen-Macomber-Whyte Company, was in attendance as usual. He presented the delegates with a handsome and useful souvenir in the shape of a pocket note-book. Mr. Whyte is anxious that his friends shall not lose sight of the fact that he is still handling Hercules wire rope.

THE ROYAL ELECTRIC COMPANY, of Peoria, Ill., expected to be represented by Manager G. G. Luthy, but unfortunately that gentleman was detained by pressure of business. He sent word, however, that the demand for the company's transformers was so great that it was necessary for the company to build another addition to its factory.

THE NEW YORK INSULATED WIRE COMPANY, New York, was represented by Mr. James Wolff, its Chicago representative. Mr. Wolff's many friends hardly expected to see him present on this occasion on account of his recent illness, but were happily surprised by his arrival at the eleventh hour. He received an enthusiastic reception.

THE ELECTRIC APPLIANCE COMPANY, Chicago, was ably represented by Mr. W. W. Lowe, president. Mr. Lowe is one of the necessities at a convention to secure its success. He was assisted by Mr. D. B. Downs, the company's Northwestern representative. These gentlemen exhibited new Packard transformers and Packard lamps.

THE ILLINOIS ELECTRIC COMPANY, Chicago, kept open house during the entire time of the convention. Its interests were looked after by Mr. A. T. Adams and Mr. D. Dewey Newman. These gentlemen proved to be delightful hosts and warmly welcomed all callers. They had a fine display of a line of their company's goods which attracted much attention.

MESSRS. M. B. AUSTIN & CO., Chicago, exhibited a line of first-class specialties, among which was the Elden circuit breaker manufactured by L. A. Chase & Co., Boston, Mass. This breaker attracted a great deal of attention. The firm was represented by Mr. M. B. Austin, assisted by W. A. Brown and E. W. Chandler. Mr. S. P. Condit, Jr., manager of L. A. Chase & Co., was also in attendance.

THE HART & HEGEMAN MANUFACTURING COMPANY, of Hartford, Conn., was represented by its much-respected and admired Western manager, Mr. George S. Searing, who never tires of talking about H. & H. push switches. Mr. Searing particularly impressed his callers with the principal features of these switches, which are, ample carrying capacity, ease of operation and positive action.

THE CENTRAL ELECTRIC COMPANY, of Chicago, had its headquarters in Parlor No. 3, and its interests were looked after by Mr. C. E. Brown, secretary, who was assisted by Mr. C. W. Cobb and Mr. Frank N. Pierce. A "Zeco" arc lamp was on exhibition and attracted considerable interest and attention. The absence of Mr. George A. McKinlock, president of the company, was regretted by his many friends.

THE SPRAGUE ELECTRIC COMPANY, of New York, was represented by its Western manager, Mr. E. B. Kittle, and the Chicago salesman, Mr. Charles G. Burton. These gentlemen were assisted by the company's Milwaukee agents, Messrs. Herman and Julius Andrae and James Heeley. These

gentlemen made a display in Room 7, of a line of the company's products, the leading feature being the Lundell fan.

THE VICTOR TELEPHONE MANUFACTURING COMPANY, Chicago, had an interesting display of apparatus in Room 6, and was represented by General Manager Mr. W. T. Blaine. Few men are better posted in their particular line of business than Mr. Blaine is in his. Having traveled extensively and being a close observer he has had an opportunity of watching the growth of the telephone business in all countries and under all conditions. To this fact

EXHIBIT OF VICTOR TELEPHONE MANUFACTURING COMPANY.

may largely be ascribed the excellence of the company's goods. The exhibit consisted of one of the company's 200-drop metallic line switchboards and a full line of wall and desk sets. Mr. Blaine was assisted by Mr. A. J. Rousseau.

THE ZAMEL ARC LIGHT METER COMPANY, of Chicago, was represented by Messrs. Charles C. Schumacher and A. G. Zamel. These gentlemen promise to place upon the market soon something new in the meter line, and make a particular request to their friends to consult them before placing orders elsewhere.

THE WESTERN ELECTRIC COMPANY, of Chicago, was represented by Messrs. A. McNab Little and William Hine. These gentlemen presented to their many callers a nicely designed card case, which was in great demand. They also distributed literature on Stanley alternating-current machinery, fuse boxes and cutouts, direct-current apparatus and "Petite" arc lamps. These two gentlemen worked hard in the interests of their company.

THE DEARBORN DRUG & CHEMICAL COMPANY, of Chicago, distributed to the delegates through its representative, Mr. W. D. Jameson, assisted by the Milwaukee representative, Mr. J. M. Frye, handsome souvenirs, consisting of a sample of this company's excellent perfumery and a very artistic blotter. These gentlemen made a display of samples of high-grade oil which is recommended for use in electric lighting and power stations.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, of St. Louis, Mo., was represented by general sales manager Mr. E. H. Abadie, who

EXHIBIT OF THE WAGNER ELECTRIC MANUFACTURING COMPANY.

was assisted by Mr. George B. Foster, the Chicago representative of the company. The exhibit consisted of a self-starting single-phase motor of one horse-power, driving a small dynamo, and a 24-inch blower directly connected. There were also shown a switchboard with illuminated-dial instruments and a line of Wagner break switches.

THE CHICAGO GENERAL FIXTURE COMPANY, Chicago, was represented by Mr. F. Overbagh. Few gentlemen in this line of business have more friends, and for conservative, sound business judgment Mr. Overbagh is considered without a peer. The company's Chicago salesman, Mr. L. W. Kittman, was also present.

THE CHARLES E. GREGORY COMPANY, Chicago, was represented by Mr. Francis B. Raymond. He states that his company carries 25,000 machines in stock at its works and is particularly anxious that all probable purchasers should inspect the apparatus in the various departments before purchasing elsewhere. Mr. A. Louis Kuehmsted, treasurer and general manager, arrived in time to attend the banquet, but returned to Chicago early the next morning on account of the pressure of business matters.

MR. MARTIN INSULL, of Chicago, occupied Room 8 with an exhibit of a complete line of electrical specialties, including the Wright Discount meter, which attracted an unusual amount of attention. This meter was described and illustrated in THE ELECTRICAL WORLD of November 26, 1898. Mr. Insull, who was assisted by his Chicago salesman, Mr. Thomas James, also had a line of Fort Wayne incandescent lamps, Pittsburg transformers, Bergmann switches, Upton enclosed arc lamps, the new Truitt regulating lamp which gives four different and distinct degrees of illumination, and D. & W. fuses and cut-outs.

THE GENERAL ELECTRIC COMPANY occupied Room No. 9 as its headquarters and was represented by Messrs. F. N. Boyer, J. Scribner and Tom Ferris, the latter being the resident representative of the company in Milwaukee. Mr. R. A. Swain and Mr. F. W. Willcox were also present. The General Electric Company made a display of a new line of small single-phase motors and the two-rate meter which was described and illustrated in THE ELECTRICAL WORLD of January 7, 1899. Printed matter was liberally distributed to the delegates.

THE PITTSBURG TRANSFORMER COMPANY, Pittsburg, Pa., had an exhibit of its transformers with cut-outs and hanger irons. The cut-out is of the single-pole type, all porcelain, and is said to successfully withstand a pressure of 2,000 volts. These cut-outs are simple and easily installed, besides being neat in appearance. The hanger irons used with the type "K" transformer are made of wrought steel and so bent that they pass on either side of the pole, making the suspension very easy. This company has placed the handling of its transformer in the hands of Mr. Martin J. Insull, Monadnock Building, Chicago, who will represent the company in that city and adjacent territory. Mr. Insull will carry a line of the products of this company at his office for inspection. He looked after the company's interests at the convention, and reported that there is a steadily increasing demand for these transformers.

OTHER COMPANIES were represented as follows: The Falk Manufacturing Company, Milwaukee, Wis., by general superintendent and engineer Mr. Clement C. Smith; Messrs. Meysenburg & Badt, of Chicago, by Mr. William Goltz; the Electric Storage Battery Company, of Philadelphia, by Mr. Frank H. Clark, Western manager; the General Electric Company's lamp works, Harrison, N. J., by Mr. F. W. Willcox; the Crocker-Wheeler Electric Company, of New York, by Mr. Julian Roe; the Commercial Electric Supply Company, St. Louis, by Mr. James D. O'Brien; the National Carbon Company, Cleveland, Ohio, by Mr. M. L. Stephenson; the Fort Wayne Electric Corporation, Fort Wayne, Ind., by Mr. E. L. Draffen; the Westinghouse Electric & Manufacturing Company by W. R. Pinckard and Walter S. Ragg; the Northern Electrical Manufacturing Company, Madison, Wis., by Mr. F. L. Stagg; the John A. Roebling's Sons Company, Trenton, N. J., by A. D. Conover, Jr.; the Buckeye Electric Company and the Jandus Electric Company, of Cleveland, Ohio, by Joseph H. Cooke; the Dearborn Electric Company, Chicago, by Mr. Charles Messer; the American Circular Loom Company, Boston, by D. W. Pattison; the Standard Carbon Company, Cleveland, Ohio, by Mr. Wallace O'Connor; the Phoenix Carbon Manufacturing Company, St. Louis, Mo., by Mr. John Rice; the Valentine-Clark Company, Chicago, by Mr. Ernest L. Clark.

DIGEST OF CURRENT ELECTRICAL LITERATURE AMERICAN AND FOREIGN

By Carl Hering.

Dynamos, Motors and Transformers.

CONTACT RESISTANCE OF CARBON AND COPPER BRUSHES.

An article, which is of special interest because it gives experimental data as distinguished from theoretical deductions, is published by Professor Arnold in the "Elek. Zeit.," Jan. 5. It gives the results of tests made with a continuous-current machine generating 100 amperes, 110 volts and 855 revolutions, the diameter of the commutator being 15.6 cm and the number of bars 48. The resistances were determined by means of two brushes on the same holder, insulated from each other, by measuring the current and voltage (apparently by leading a current into one brush and out of the other). The first tests were made with carbon brushes, the surface of the commutator having a dark brown color. The surface of a brush was 3 sq. cm, and provisions were made that the whole surface was in contact. The results of these tests are given in the adjoining Figs., 1 and 2. The full line curves in Fig. 1 show the dependence of the resistance on the current density under the brushes, each curve representing a different speed; the dotted curves show the dependence of the resistance on the speed for different current densities. Fig. 2 shows the dependence of the contact resistance on the contact pressure at different speeds, the current density being kept constant at 6.3 ampere per sq. cm.; both these are for carbon brushes, the commutator having a dark brown color. The first figure shows smaller contact resistances than the second, which is due to the fact that before the first test the machine was run for several hours, while during the second test the contact was disturbed by changing the pressure. The results show the interesting fact that the contact resistance, especially at greater peripheral speeds, diminishes rapidly with increased current density. This is no doubt due to the heating of the brushes, as it is dependent on the speed. At higher densities the commutator is apt to become colored, which may explain the lowering of the resistance, as for a polished commutator the contact resistances were greater. With a constant current density the resistance first increases with the speed and then diminishes. For 2 and 5 amperes per sq. cm., for instance, the resistance becomes a maximum at about 750 revolutions, which may have some connection with the natural period of vibration of the brushes and the number of commutator bars. After these tests the commutator was polished and slightly oiled, and it was found that both before and after oiling the contact resistance at the same pressure, 190 grams per sq. cm., was greater than in the first test. Oiling itself gives a smaller increase in resistance. The results are shown in Fig. 3, which applies to carbon brushes. The next test was made with copper brushes, the pressure being 125 gr. per sq. cm., the surface of the brushes being 2.75 sq. cm., and the results are given in Fig. 4, which shows the dependence of the contact resistance on the current density, and Fig. 5, which shows the dependence on the speed. As with carbon brushes, the resistance diminishes with increased current density, but not as rapidly. For about 250 revolutions it reaches a maximum, while with the lighter carbon brushes this occurred at 750 revolutions. The natural period of vibration of the heavy copper brushes is much less than that of the carbon brushes. The weight of the brushholder with carbon brushes was 195 grams, and with copper brushes 685. According to these tests, the contact resistance of carbon for the usual current densities of 8 to 5 amperes per sq. cm. and a peripheral speed of 6 to 12 metres can be taken to be 0.15 to 0.25 ohm per sq. cm., and for copper brushes at the usual current density, 0.005 to 0.015 ohm per sq. cm. He then makes some calculations from the results published some time ago by Dettmar, showing good agreement for carbon brushes. The energy lost in the formation of sparks is to be considered only when the e. m. f. of commutation is too large or too small. As he intends to show in a subsequent article, the current density under the brushes varies very greatly when sparks are formed; if the current density remains constant, this loss is zero. There is a loss through Foucault currents due to the fact that the bars pass through a stationary magnetic field produced by the current flowing through the brushes; this is briefly discussed, and is shown to be of importance in low-voltage dynamos for electrolytic purposes, in which the commutator has been found to become warm, while the rest of the armature remains cool. The current strength per bar should if possible not exceed about 500 amperes. The loss due to the friction of the brushes is then discussed. In the above mentioned tests the normal pressure was 100 to 200 gr.; a pressure of 100 may be considered as light, and one exceeding 250 as quite strong. Carbon brushes require somewhat more pressure than those of copper, especially for car motors. The friction coefficient between brushes and commutator when in good condition can be taken to be 0.3 for carbon brushes and 0.2 for copper brushes. The formula for this loss in watts is

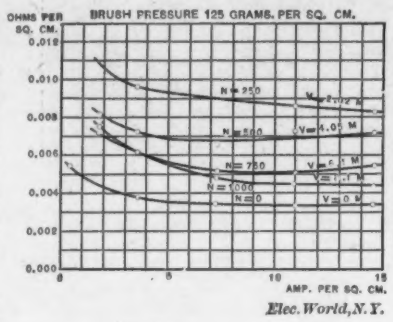


FIG. 4.

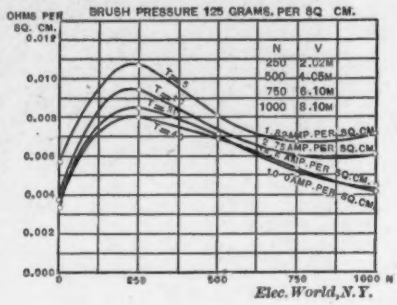


FIG. 5.

9.81 multiplied by the pressure of all the brushes in kilograms, by the peripheral velocity of the commutator in metres per second, and by the friction coefficient. The increase of temperature in the commutator is then discussed, a formula being given, together with several examples.—Arnold. "Elek. Zeit.," Jan. 5.

SPARKING OF CONTINUOUS CURRENT MACHINES.

In the concluding portion of his long article in the "Elek. Zeit.," Dec. 29, Mr. Fischer-Hinnen continues his mathematical discussion (see "Digest," Jan. 14), and develops some formulas, which are not in such a form that they can be given here; in his discussion, however, he brings out a number of points of interest. Concerning the cause of the formation of the sparks he refers to the American Institute paper of Reid, read about a year ago, in which that author states that the formation of sparks is due to too great a current in the brushes, and considers that the spark due to the actual breaking of the current, is harmless. The present author shows that one of his analytical deductions not only proves this, but also shows that no spark due to a break can arise, and that therefore the small arc seems to be caused before the actual break by the melting off of the metal. He then discusses the formation of sparks, basing it on the loss of energy at contact, and incidentally shows that even with only one volt there may be a current density which is quite sufficient to melt the metal before the actual break occurs, thereby causing visible

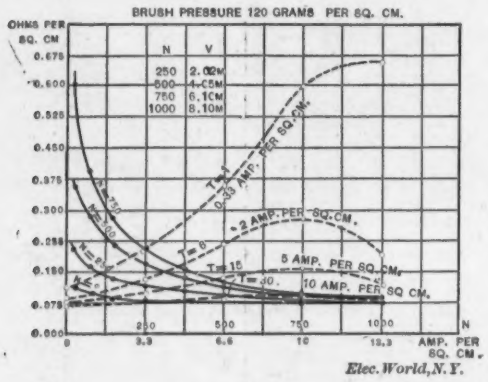


FIG. 1

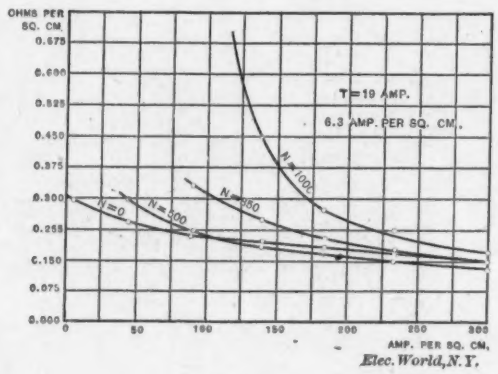


FIG. 2.

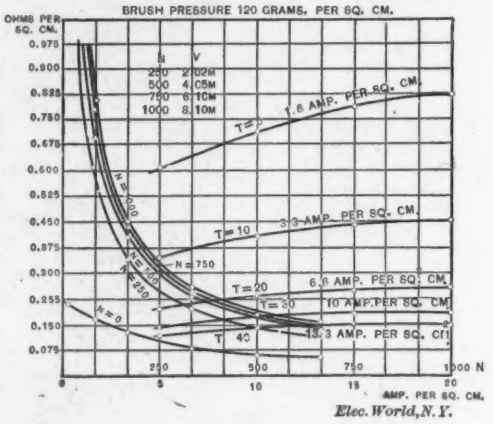


FIG. 3.

sparks. His equation shows that the tendency to sparking increases with the square of the voltage, and the strength of the spark will be less, the quicker the breaking and the less the surrounding temperature. Some curves show the current during commutation. The maximum current density in the brushes is then discussed analytically, and although no values are given he draws some important conclusions. Among these he shows that the current intensity at the contact points may under certain conditions be extremely great, sufficiently so to melt the metal; the process of commutation would under such circumstances be disturbed. Also that a machine may

run with very little sparking, but nevertheless may develop considerable heat, accompanied by a bad wearing of the commutator; in such cases, after a certain time, there will be an appreciable increase in the sparking. The explanation of this is that the surface of contact is gradually diminished, forcing the sparks gradually to the end of the brush, where they become visible. In many cases an examination of the commutator surface will enable one to draw conclusions concerning the faults of the machine. If, for instance, the bars are eaten away where they first touch the brush, it shows that the commutation is too sudden, but in such cases the sparks will soon be forced to the other side of the bars. Sometimes the surface is uniformly affected, and in such cases in general the wear is very slight. Commutators for alternators or rotary transformers must be considered in quite a different way. The discussion not only shows the important part that the current density of the contact surface plays in the formation of sparks, but also how to meet this difficulty. As the current density is a function of the width of the brush, the simple method is to increase the length of the commutator. The difficulties are greatest with low-voltage machines and carbon brushes, and in these the current density is usually made 6.7 to 7.7 amperes per sq. cm. as a maximum, in order not to increase the length of the commutator too much; the only method, then, is to increase the number of brushes. With high-voltage machines it is much simpler, and in these the current density may be brought down to 3.5 to 5 amperes. It is often thought that a machine which does not run well can be made to do so by using carbon brushes, but this is not always right, especially when the surface speed of the commutator is very great, such as 10 to 12 metres per second, for in such cases the use of carbon brushes may make matters worse, although at slower speed, such as 6 to 8 metres, they may often be better than copper brushes. According to his experience, the maximum speed for carbon brushes is about 9 metres. The resistance of the carbon brushes changes with the speed, although there is a difference of opinion concerning this. He then compares the present with his former theory, concluding with the explanation of how the self-induction coefficient may be calculated, this factor being a very necessary one in his formulas; this calculation is difficult for smooth armatures, but can be made quite accurately for others. A table of the self-induction coefficients of single coils under various circumstances is given to facilitate calculation. He works out some examples and gives a table containing some of the quantities used in his formulas for nineteen different machines.

SPARKING LIMIT FOR CONTINUOUS-CURRENT MACHINES.

A rule of thumb, which has done good service and is still used largely to-day, is that the induction below the edge of the entering pole piece should have a certain minimum value, about 1500 for drum armatures and 2500 for ring armatures. This rule, like many others, is useful as long as it is applied to similar machines. In a recent paper by Gisbert Kapp, reprinted in the "Elek. Zeit.," Jan. 5, he develops a theory of sparkless commutation which is intended to be a medium between the strictly correct mathematical calculations, on the one hand, and the simple rule of thumb, like the above, on the other. He endeavors to offer a substitute for this rule of thumb in the form of a formula based on a scientific foundation and of general application, which at the same time is so simple that the constructor need not hesitate to use it. The exact limit of sparklessness is of value only in order to enable a proper factor of safety concerning sparks to be determined, just as is done in many other cases in the construction of machinery. During the first half of the period of commutation the coil acts as a motor, while in the second half it acts like a break; he bases his deductions on this, but limits himself to the second half of the period. Sparkless commutation can take place only when the energy conveyed to the coil is exactly equal to that which is stored in that coil after it leaves the brush. The formula cannot be reproduced here, as it should not be used without a clear understanding of all the conditions involved. The formula is to the effect that the induction in the air gap below the poles must be greater than a constant multiplied by the "linear current density on the periphery of the armature," divided by the number of commutator bars under a brush, the constant being determined empirically. This formula differs from the above mentioned rule of thumb in that it contains the current density and the number of bars under the brush. It gives the necessary condition, but not the only one necessary for sparkless commutation; it does not, for instance, contain the number of armature rods per commutator bar. The value of certain constants involved is briefly discussed, and the values found in certain machines are given.—Kapp. "Elek. Zeit.," Jan. 5.

MAXIMUM OUTPUT AND EXCITATION OF DYNAMOS.

Some general remarks on the maximum power of generators, and on the excitation, chiefly of alternators, are given by Mr. Aliamet in "L'Elec.," Dec. 24. It seems to be introductory in part to a description of the Leblanc method of compounding alternators, which has already been referred to in the "Digest," and is described in THE ELEC. WORLD Jan. 14, p. 58. The present article, however, is of interest aside from this special method of compounding. Concerning the maximum power of generators, he states that having given a dynamo in which the air gap, the tangential velocity of the revolving part, the weight of the copper and the heat losses, are all constant, it is evident that for the maximum power per pound weight of the dynamo the weight of copper will be equal on the armature and the field. On the assumption of this equal division of the weight of copper he then discusses the various types of machines. A continuous-current dynamo of this sort for constant voltage would run very badly; the commutation would be very bad, the sparks very plentiful, and the voltage for different outputs could not be maintained constant with a shunt excitation alone. In such a continuous-current machine for constant currents the sparking would remain the same, but the current would remain practically constant, owing to the armature reaction; a constant-current machine is therefore well adapted to this equal division of the copper; the sparks at the brushes will always exist, but can be provided for by special apparatus, such as the blower in the Thomson-Houston arc-light machines. An alternator for constant currents for series distribution is well adapted to such an equal division of the copper on the armature and the field; the difficulty of commutation does not exist, and the large armature reaction, owing to this equal division of the copper, will automatically regulate the output; constant-current alternators can therefore be well adapted to give the maximum output, but unfortunately it is not possible to connect such machines in series except by coupling their shafts, and their use is therefore generally limited to feeding individual circuits. A constant potential alternator is not well adapted for the equal division of the copper, as the armature reaction would be such that it would be impossible to obtain even an approximately constant potential; a rheostat in the field circuit, even when operated automatically, would not be sufficient to regulate the voltage. It follows, from the above, that constant-current machines are well adapted for a high output per pound weight, while this is not the case with constant-potential machines. This applies in general to both generators and motors, whether constant current, alternating current or polyphase current. In constant-current dynamos the commutation alone limits the proportion of copper on the field and armature; this division should be made such that the ampere turns per centimetre of periphery of the armature does not exceed 130 in large machines or 80 in small ones. The constant-potential alternators can be considered as such only within very narrow limits of the output, especially if there is a wattless component. For a fall of 20 to 30 per cent. in voltage at the maximum output, the power factor is 0.8, the output of the armature is very limited, and only a very small proportion of the whole amount of copper can be put on the armature; such machines would therefore be expensive relatively to a continuous-current dynamo of the same power. This is shown by the fact that the armature of a modern alternator in which the voltage is nearly constant does not have more than 75 ampere turns per centimetre of periphey of the armature, even in large machines. He then discusses how the voltage in any dynamo is maintained constant aside from the question of commutation. The only method is to keep the resulting flux in the air gap constant. This can be accomplished only if the unavoidable variations in ampere turns of armature reaction are compensated "preventively" by simultaneous variations in the ampere turns of the field; by preventively he refers to a method like compounding as distinguished from other forms of regulation, in which the changes of excitation are lagging in time and are therefore not preventative. He then discusses the compounding of continuous-current dynamos, which is well understood. He calls attention to the lagging in case of over-compounding, which is caused by the variation of the resulting flux in the air gap, and this is overcome by reducing as much as possible the Foucault currents accompanying such variations, by laminating the fields and encircling the cores with an envelope of copper. Compounding the alternators is next considered. If this problem could be solved in a satisfactory way it would enable machines to be used having an equal weight of copper on the armature field; such alternators, with a larger armature reaction and an air gap reduced to a minimum, would evidently be much better than those at present used. As the question of commutation does not enter, it would then be possible to construct constant-potential alternators having a specific output higher than that of continuous-current dynamos, but unfortunately the compounding of alternators is much more difficult than that of continuous-current machines. The demagnetizing effect of the armature reaction is not only a function of the output of the machine, but is also a complex function of the wattless component of the current, and the demagnetizing effects of this component in the air gap are greater for an equal output than those of the current which is in phase with the voltage; an alternator should therefore be compounded proportionately to its energy output and to a certain complex relation with the wattless current. The methods of exciting the alternators are then discussed. Those excited by continuous currents he calls synchronous, and those excited by polyphase currents non-synchronous; the latter are used largely as motors, but seldom as generators, although he thinks that it is certain that in the future they will be so used. The compounding of a non-synchronous alternator is much simpler than that of a synchronous one; the magnetizing components of the exciting alternating currents are completely wattless; it is only when these are in advance of the voltage that the voltage can remain constant, and even be increased in proportion to the output. In the case of a transmission of energy by non-synchronous motors the generators should be considerably larger than the motor, if one wants to be able to start while the generator is running at full speed; if the two machines had about the same power the starting of one of them would interfere with the excitation of the other, and the system could not be brought up to speed. With a generator that will have a constant potential, the impossibility of using a generator and motor of the same power no longer exists. Polyphase alternators can be easily compounded if they do not give a wattless current, and it suffices, then, to rectify a fraction of the alternating current proportional to the main current, and as in contiuuous-current machines, use this for exciting the series winding. Compounding, strictly speaking, cannot be accomplished with the aid of con-

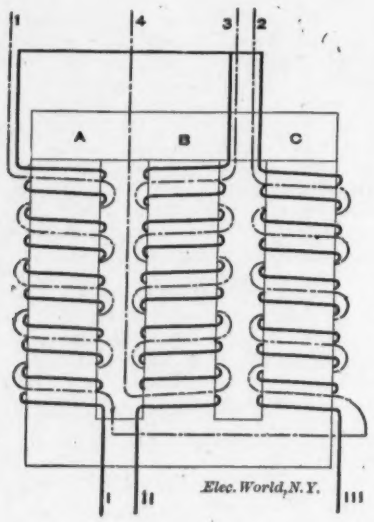
densers. In conclusion he sums up his remarks as follows: That it would be economical to use machines with a great armature reaction, and therefore armatures with much copper and small air gap, especially in the case of alternating generators and motors; and that it is necessary in the use of such machines to have some general and effective way of compounding alternators. He believes that Leblanc has offered a general solution of this problem in his paper above referred to.

REGULATING AND COMPOUNDING ALTERNATORS.

In a long abstract of a recent paper by Lahmeyer, published in the "Elek. Zeit.," Jan. 5, he discusses the question of the excitation of alternators, and describes several ways in which they are compounded. He calls attention to the fact that to regulate the field by means of resistance in the field circuit involves the loss of considerable energy when the alternator is large. For a 1000-kw alternator, for instance, the regulating resistance may have to dissipate as much as 4 kilowatts, which is quite an appreciable quantity, even in a large station. He therefore recommends using a separate exciter and regulating by means of a resistance in the field circuit of the exciter. He discusses whether the exciter should be a series or a shunt machine, and concludes that the latter should in general be given preference. He describes, with the aid of a diagram, a graphical method for determining the resistance of the various steps in this regulating resistance, so as to enable the voltage of the alternator to be regulated to an equal degree, at different voltages; it may also be applied for a constant potential at the feeding points, instead of at the alternator. Compounding alternators involves difficulties when the main current is rectified, but instead of using commutators for this he suggests using a rotary converter, which must not be a motor dynamo, but a true rotary converter, with only one armature winding connected both to a commutator and slide rings, as usual. The alternator should have two windings, the regular one fed by an exciter, and the auxiliary or compound winding for the current from this converter. The main current passes through the primary of a transformer whose secondary is connected with the rotary converter, the current in which will then be proportional to the main current, and this, after rectification, passes through the auxiliary winding, which then acts like the series winding in a continuous-current machine. Another method is to use a transformer having a magnetic shunt, that is, a regular transformer with two cores and coils and in addition a third core connected to the others through an air gap and carrying a coil through which the main alternating current flows; the other primary coil is a shunt to the alternator, and the secondary current from both of these is transformed in the rotary converter and furnishes the whole exciting current. An increase of the main alternating current diminishes the magnetic leakage through the shunt-core, thus increasing the flux through the secondary core, thereby increasing the exciting current. He questions whether this method will be useful in practice, and suggests that a good machinist is probably the best automatic apparatus—Lahmeyer. "Elek. Zeit.," Jan. 5.

TRANSFORMING TRI-PHASE INTO SINGLE-PHASE CURRENTS.

A brief, illustrated description of Grassi's method, translated from the Italian, is given in "L'Eclairage Elec.," Dec. 31. Referring to the adjoining illustration, it is seen to consist of an ordinary three-phase transformer, the three secondaries of which, having the same



number of windings, are connected in series. The primary of the core *B* is wound in the opposite direction to that of the other two, while of the secondaries the two outside are connected in series, and so that the directions are opposite to each other, and they are then connected in series with the third secondary, in either direction, the voltage remaining the same in both cases; the total voltage is equal to twice that at the terminals of any one of the three secondaries. The disadvantage that the energy absorbed is considerable is overcome by changing the number of windings of that primary coil which is wound in the opposite direction to the two others; if the number of windings is doubled on one of them, the energy absorbed at no load is as small as that on the ordinary transformer. It was found that there is a difference between the primary currents depending on the groupings of the secondaries among themselves; the combination which he adopted is that the one described above, which gives the most uniform division of the currents, they being equal in the primaries *I* and *I I* in the adjoining figure, and that in the coil *I I I* being slightly more than that in the other two. He also investigated the effect which the number of windings of the secondaries has on different cores, and he found that the best conditions should be obtained when one of the coils, *A* or *C*, has a number of windings slightly greater or less than the other, and when the coil *B* is wound in the opopsite direction of that one of the other two which has the greatest number of windings. He also investigated a method in which the middle core has two primary coils connected in series with each other, and with each of the primaries of *A* and *C*, their junction forming the middle terminal and the ends of the other two coils forming the other two terminals of the three-phase circuit; this arrangement has also given good results. A complete theory of the arrangement is promised.—"L'Eclairage Elec.," Dec. 31.

ROTARY CONVERTERS.

The beginning of a long, illustrated article of a general character by Mr. Ritter, on rotary converters, the use of which, he says, is increasing. He discusses the starting of such machines, the excitation, the direction of rotation, the voltage and frequency, the method of charging accumulators and the capacity. He shows several methods for adapting them for charging accumulators. In such a case the voltage must be capable of being increased and regulated; the Alioth method is described and illustrated; in this there is a small alternating-current generator in series with the machine, and arranged so that its excitation can be varied; it must be mounted on the same shaft and have the same number of poles. Another and better solution of the problem is to use a small generator in series with the continuous current and varying its excitation.—Ritter. "L'Eclairage Elec.," Jan. 7.

RECTIFYING ALTERNATING CURRENTS.

In the concluding portion of his article (see "Digest" Jan. 14) he discusses mathematically the relations when both the direct and the reverse currents are passed through the same apparatus, in which case four of the so-called valves must be used. In a similar way he discusses the case of the rectification of a three-phase current with the aid of six of these valves.—Kallir. "Zeit. fuer Elek.," Dec. 25.

REFERENCES.

Single-Phase Motors.—A description of the motors made by the Wagner Company, of St. Louis.—"West. Elec.," Jan. 14.

Power.

PADERNO.

The very full description of this water-power installation in Italy, the first part of a translation of which was noticed in the "Digest" Jan. 7, is continued in the Lond. "Elec.," Jan. 6, the present portion referring chiefly to the electrical features. The high-voltage current is generated directly without the use of step-up transformers. The length of the line to Milan is 20 miles, the receiving station being divided into two parts, a steam-generating station and a transformer station, which receives the energy from Paderno. These transformers and steam alternators supply three-phase currents at 3600 volts and 42 periods, and both of them may be coupled to the same bus bars. From this centre of distribution three distinct kinds of service are supplied; energy for motors and lighting is furnished through underground wires in the form of three-phase currents at 3600 volts, and secondary mains at 150 volts; power is supplied for traction purposes through motor generators; and the old Edison network is supplied with continous currents by means of motor generators in a local substation. When the question was discussed whether the two or three phase system should be adopted it is said that the illusion was destroyed that with the two-phase system the joint supply for motors and lighting was easier, and it was proved that the transmission was less economical, for which reason the two-phase system was abandoned for the three-phase, which allows for a mixed supply equally well, and perhaps better, and being perfectly symmetrical in all its parts, presents a system of distribution more uniform and more elastic. The choice of the frequency was limited to between 40 and 60, and as 42 was already used in the old plant, this was selected. It has been proved that incandescent arc lamps are very satisfactory at this frequency. After much discussion it was decided to adopt 13,500 volts for the primary transmission, and this was sanctioned by Ferraris. In order to avoid too great a skin effect, the diameters of the wire ought not to exceed five-sixteenths of an inch, and to reduce the loss to 9 per cent., eighteen wires were necessary. The total power absorbed by the original generators is 2160 horse-power or 1590 kilowatts, the speed being 180 and the frequency 42. The dynamo has a stationary armature and revolving field. The question of why that type was chosen in preference to the inductor type, was briefly discussed; the principal advantages of the latter are the thorough mechanical construction of the revolving part, the abolition of the rubbing contacts and the smaller consumption of energy for excitation, with a higher efficiency. The disadvantages are in the exciting coil of 16 to 18 feet in diameter, the iron is badly utilized, and the machines are heavier; there is also an enormous magnetic leakage, which necessitates making parts of the steam engine, near the generator, of non-magnetic

material. The Brown alternator, which is used, is then described with the aid of good illustrations, the internal construction differing essentially from other machines of its kind. The internal reaction is guaranteed to be within 5 per cent. for a non-inductive load and 16 per cent. for an inductive load, with a power factor of 80 per cent.; the efficiency is 95 per cent. in the first case and 93 in the second. The description of the plant is to be concluded.—Semenza. Lond. "Elec.," Jan. 6.

HIGH VOLTAGE TRANSMISSION PLANTS.

An interesting list of plants in which 10,000 volts and over are used, is given in the "Elec. Tech.," Dec. 31. At Donaueschingen the voltage is 10,000, and the distance 26 kilometres; at Eichdorf-Gruenberg the power is 406 kilowatts (the voltage being presumably about 10,000); in France the plant at Ardieres uses 10,500 volts, the distance being 24 kilometres, and at Lavrey, 12,000 volts and 30 kilometres; in Switzerland, at Combe-Garrot, 14,000 volts, 20 and 48 kilometres; in Monthoron, 15,000 volts and 60 kilometres; in Canada, at Trento, 10,000 volts and 21 kilometres; at Three Rivers, 12,000 volts at 27 kilometres; Chambly-Montreal, 12,000 volts and 60 kilometres; in Italy, at Paderno, Milan, 14,500 volts and 33 kilometres; in the United States, at San Antonio, 10,000 at 24 kilometres; Stockton, 10,000, at 16 kilometres; Salt Lake City, 10,000 volts and 22 kilometres; Folsom-Sacramento, 11,000 volts and 38 kilometres; Fresno, 11,000 volts and 56 kilometres; Blue Lakes, 11,000 volts and 63 kilometres; Bakersfield, 11,500 volts at 25 kilometres; Minneapolis, 12,000 volts, and Mechanicville-Schenectady, 12,000 volts and 39 kilometres.—"Elec. Tech.," Dec. 31.

ELECTRICITY IN MINING.

Attention is again called to the recently achieved success of the application of electricity for various purposes in mining, in a brief editorial in the "Eng. and Min. Jour.," Jan. 14. It is stated that electricity is now being used for all the operations in mining; while there was a hitch at first about the drill, the gadder and the coal-cutter, it seems now to have been overcome, "so that it is now safe to say that there is nothing done in mining which can be done by steam power directly, or indirectly by compressed air, or wire-rope transmission, which cannot be done equally well by electricity—the selection depending upon the difference in the first cost, running expense and maintenance. The strange thing is that in some cases electricity has helped its competitors, as, for example, in the combination with air compressors." One of the great fields for electricity is where it can take advantage of water power, and here the difference between the old and the new conditions is that formerly the water power had to be above the point of application, while now it may be thousands of feet below.—"Eng. and Min. Jour.," Jan. 14.

REFERENCES.

Alternating-Current Transmission.—The continuation of his article describing his recent experiments in alternators.—Leblanc. "L'Eclairage Elec.," Dec. 31.

Duplex Inclined Elevator.—A brief, illustrated description of an inclined-plane elevator for both raising and lowering passengers, designed by Reno, and recently installed in a Brooklyn store.—N. Y. "Elec. Eng.," Jan. 12.

Traction.

ELECTRIC RAILWAY STATISTICS FOR GERMANY.

In the issue of Jan. 5 the "Elek. Zeit." publishes its annual table of statistics of electric railways for Germany in the form of seventeen pages of a table, containing well-filled columns of information. These statistics refer only to public railways, and not to private lines. The information is for the year ending the 1st of September, therefore covering a period of one year since the last tables were published. During that time there was considerable development of this industry in Germany, as is shown by a comparison with the results of the previous year. One of the features of interest is that a number of the roads are carrying freight. A table is also given showing the growth of this industry from the year 1891, when only three cities had electric lines, while now there are sixty-eight. The total length of lines is 858 miles, an increase of about 50 per cent. over the previous year, or a total of 1164 miles of track. The number of motor cars is 3190 and the number of trailers 2128; the capacity of the machinery is 33,333 kilowatts, which is an increase of 33.8 per cent. over the previous year. Adding to this the extension made in the last four months of last year, the total length at the beginning of this year was 930 miles, or 1260 miles of track. This would reach from Cologne to St. Petersburg, via Koenigsburg. The capacity of the power stations does not include that of the accumulators, which are now being used very largely. The total capacity of these batteries is 5118 kilowatts, thus making a total of 38,451 kilowatts. Adding this to the power of the machinery and batteries used for lighting gives a total of about 200,000 horse-power. The average power in kilowatts per kilometre of track is 20.7, as compared with 21.7 in the previous year, and the average number of kilowatts per motor car is 14.2, as compared with 14.6 in the previous year. As a rule the trolley system is used, the underground conduit system being installed only on some short lines in Berlin and Dresden. The so-called mixed system, in which both the trolley and accumulators are used, being charged while the cars are running on the trolley line, is increasing in favor in the larger cities, and is at present in use in Berlin, Dresden, Hagen and Hanover. A few lines, which are mentioned, are using the regular accumulator system The old line from Frankfort to Offenbach is still using the original system, in which the overhead conductors are split tubes, the same system which was originally used on this pioneer line many years ago. The tables give only the information concerning the construction and equipment of the lines, but no data concerning their operation.—"Elek. Zeit.," Jan. 5.

REFERENCES.

Surface-Contact System.—A German translation, with the illustrations, of the description of the Demeuse system, noticed in the "Digest" Feb. 5.—"Zeit. fuer Elek.," Dec. 25.

Dover.—A short, illustrated description of the American street railway plant in that city in England.—N. Y. "Elec.," Jan. 12.

Installations, Systems and Appliances.

HIGH VOLTAGE ACCUMULATOR PLANT.

A rather unusual system of some interest, which was installed at Naples, Italy, nearly ten years ago, is described by Mr. Bonghi in an Italian publication, an abstract of which is published in "L'Eclairage Elec.," Dec. 31. The steam engines at the generating station have a total of 1160 horse-power, and the dynamos generate a continuous current between 500 and 800 volts, and are separately excited; they can be connected in parallel to each of three circuits of two conductors, which lead to three accumulator substations. The first of these is about 4000 feet distant, and contains eight groups of seventy cells and two groups of another type. The second station is distant about 7300 feet, and contains sixteen groups of cells. The third is 14,000 feet distant, and contains eight groups of cells. At each substation four groups are connected in series, forming four separate sections; the other groups can be connected in parallel to each section. The substations are connected to the primary station by only two wires, and they can be supplied with current separately or in parallel. Each substation feeds two distinct three-wire networks. Large establishments like a theatre are supplied directly from a five-wire system. The greatest distance from the station to a consumer is 19,000 feet. The primary voltage at the substations varies from 400 to 550 volts, or for over-charging it can be made 750 volts. For charging the cells a rotary converter is used, and it also equalizes the various sections. The maximum voltage at the station varies from 500 to 800. Arc lamps are placed ten in series across the primaries from the substations. There are altogether 156 arcs and 40,000 incandescents lamps of 16 candle power. Motors and street railways are supplied from a special set of mains at 250 and 500 volts from the substations or the principal station. The primary current from the dynamos, together with that from the batteries, is used for feeding the networks, or the former is used for charging the cells, either during discharge or when not discharging. The current generated by the dynamos is always the maximum that they can produce, and the machinery at the primary station is therefore always running at full load. By means of switches the whole system is made very flexible. Regulation is accomplished by cutting cells in and out. The energy sold is equal to 65 or 70 per cent. of that produced; in other words, this represents the total efficiency from the dynamo to the meters. As the primary station is always running at full load, the consumption of coal does not exceed 6.2 pounds per kw hour. The cost of renewing the positive plates of the accumulators is less than usual; in the Tudor cells it is done about every five years, and in the E. P. S. every three years at a maximum.—Bonghi. "L'Eclairage Elec.," Dec. 31.

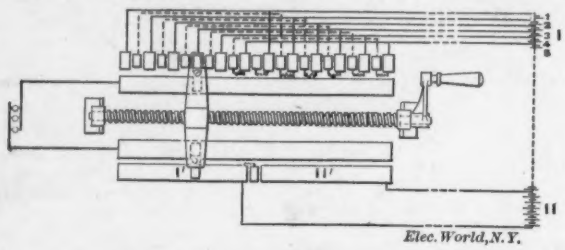
CENTRAL STATION STATISTICS FOR THE UNITED KINGDOM.

At the beginning of each year the Lond. "Elec." publishes a large table, with many well-filled columns of information for each of the stations in London and the provinces. This year it is published as a supplement to the issue of Jan. 6, and is unusually large, being no doubt the most complete table of its kind published for that country. No summary of the information is given. Editorially it is stated that the most notable feature of the year is the large increase in the number of stations using 200 volts and over, these now numbering 87, of which about half do not give an alternative supply at 100 or 110 volts. There is also a considerable improvement in the motor connections; last year only five stations had a motor-load of over 100 horse-power, while this year there are eighteen that have more than 100 horse-power in motors connected to their mains.—In another portion of that journal tables and curves are given for the cost of operation of a number of the stations for 1896 and 1897, showing the progress made in the economy of generation and supply of electricity during two years. The stations are divided into those which are owned by the municipalities and those owned by companies, but the information is chiefly of local interest. Curves show the relation between the various items of cost and output per annum.—In another portion of that issue a diagram is given showing the lamp connections during the past eight years for the stations in London, most of which show about the usual increase during the year. The total number of connections in the United Kingdom up to the end of 1898 is 5,206,000 lamps of 8 candle power, or their equivalent, which is an increase of about 1,250,000 over the previous year, about one-third of which has been acquired in London and two-thirds in the provinces. The increase during 1897 was 900,000. Diagrams show the increase, from which it is seen that it is much more rapid for the provinces than for London. Another diagram shows the relative number of connections to continuous-current stations, from which it appears that the continuous current is still in the lead, and that in London the combined continuous and alternating current connections is almost equal to it, and much greater than the number of lamps supplied by alternating current alone, while in the provinces this is reversed. It shows that a number of the alternating stations have added continuous-current machines for supplying power. Another diagram shows the relative strength of the companies and municipalities in London and the provinces, the companies having the majority of lamp connections, but this is due entirely to the London

companies, as the municipal load in the provinces continues to grow at a great rate, and is much greater than the load on the stations operated by companies. There will soon be as many municipal as company lamp connections in the United Kingdom.—Another column gives the electric lighting notices for the next year.—Lond. "Elec.," Jan. 6.

REGULATOR FOR CUTTING OUT ACCUMULATORS.

An improved form of regulator for cutting in and out the end cells of a series of batteries, for purpose of regulation, is described in the "Elek. Zeit.," Dec. 29; it was devised by Erlacher and Besso. In such regulators, as is well known, the cells at the end of a series are cut in or out for adjusting for the voltage during discharge, and are cut out on charging, after they are fully charged. The object of the present improvement is to diminish the number of cells which are connected to the regulating switch, and therefore also the number of contacts and connecting wires. This is accomplished by cutting out individual cells at one end of the series and a whole group of cells at the other end. If, for instance, eleven cells are to be used for regulating purposes, only five cells at one end are connected to this switch with six leads, and a group of six cells with two leads are connected to the other side of the switch, thus making seven leads (presumably eight are meant), with which the same result will be accomplished as formerly with twelve leads. The adjoining figure shows the method of connecting. After the first five cells have been switched out, the switch will cut out the group of six cells and at the same time switch the other five cells into circuit again, after which each of these five is then cut out again in succession, thus giving the same amount of regulation as is obtained from eleven cells at one end. If several groups of cells are to be regulated with a switch it is recommended to use two separate switches, one of which cuts out individual cells and the other groups of cells, the two switches being so connected that after one is turned to its extreme limit the other cuts out one group. The same switches are constructed so as



Elec. World, N.Y.

to operate automatically by means of a relay controlling a motor, which exerts a tension on a spring which, on being released, operates the switch; this operates in both directions; this form is merely mentioned, but not described.

REFERENCES.

New Union Station at Boston.—A brief, illustrated description of this new railway station, which was opened on the first of this year. Electricity will be used extensively for lighting and for elevators, of which there are nineteen; it is also proposed to move the entire suburban railroad traffic into and from this station by electric power. —N. Y. "El'ty," Jan. 18.

Economy of Small Electric Light Plants.—The first part of an article on why some small electric light plants do not pay, in which the author discusses the question from the engineering and business points of view, and shows that there are plenty of paying plants in towns of 12,000 to 15,000 inhabitants.—Cravath. N. Y. "Elec. Eng.," Jan. 12.

Method of Charging.—A discussion of this method, which was described in the article by Meynier, noticed in the "Digest" Oct. 15, in which the object was to establish a differential tariff, which has all the advantages of the Wright system without the expense of the extra apparatus.—Dick. "L'Ind. Elec.," Dec. 25.

Municipal Electrical Supply.—The conclusion of the author's long serial on the commercial and business aspects of municipal electric supply. He describes the fitting up and managing of a show-room connected with the station.—Gibbings. Lond. "Elec.," Dec. 30.

Methods of Charging in America.—A short article giving an account of the various methods used in selling electricity in this country.—Hale and Codman. Lond. "Elec. Rev.," Jan. 6.

Recent Legislation Concerning Electric Supply.—The first part of an article which is chiefly of local interest in Great Britain.—Browne. Lond. "Elec. Rev.," Jan. 6.

Wires, Wiring and Conduits.

NEW METHOD OF SOLDERING WIRES.

An interesting method of soldering wires, particularly overhead wires for telegraph lines, without the use of a soldering iron, stove, or torch, is briefly described in the "Elek. Zeit.," Jan. 5. It is the invention of Mr. Stuermer, and is based on the use of what is called Moissan mixture, the material used being called a soldering cartridge. This mixture, which was duly described in the "Digest," May 28, when first discovered, but at that time was considered to be the discovery of Goldschmidt, consists of pulverized or granulated metallic aluminum and a cheap oxide, which may furthermore be mixed with some inert material for limiting and regulating the heat which is produced by the reduction of the oxide (or, more correctly speaking, by the oxidizing the aluminum). The Stuermer cartridge consists of a hollow cylinder, either in one piece or in two halves, and contains, first, a layer of solder, around which is a certain quantity of a mixture of aluminum and oxide of iron or lead; into this mixture is stuck a short piece of magnesium band, which inside of the cartridge is surrounded with a mixture of powdered aluminum and peroxide of lead for igniting the main charge; the outer end of this band is coated with a material which can be ignited by a glowing body such as cotton wick, thus enabling the cartridge to be lighted even in a strong wind. The whole cartridge is surrounded by an elastic material which confines the heat. The joint is first covered with the usual soldering acid, the cartridge is then brought over it, tied to keep it in place, and then ignited. When the cartridge is in two halves, a muffle is used to hold it in place. For light soldering it is said that it may be possible to dispense with the solder entirely, if the aluminum is mixed with tin oxide and lead oxide, in such proportion that the heat produced is sufficient to melt the reduced metal, which then forms the solder. These cartridges are made by Neuschaefer and Funk, in Magdeburg, Germany.—"Elek. Zeit.," Jan. 5.

Electro-Physics and Magnetism.

DIELECTRIC STRENGTH OF INSULATING MATERIALS.

The results of some experiments made to test the dielectric strength of glass, hard and soft vulcanized rubber, mica, fibrous cardboard, paper, oils and air, conducted by Mr. Gray, are published in the "Phys. Rev.," Nov. The tests were made with a step-up transformer, giving as high as 100,000 mean volts. Specimens of crystal glass had a dielectric strength of 285,000 volts per cm, in a thickness of 1 mm, and this was reduced to 200 kilovolts when there were four layers, making a total thickness of 4 mm. A similar falling off was shown for hard rubber when several layers were used. The following are some of the figures obtained: Mica, 2000; hard rubber, 500; soft rubber 450; micanite, 400; paper, 400 to 600; fuller board, 200, and air, 50 kilovolts per cm; but these are only rough average values. The dielectric strength of oils was found to vary with the e. m. f.—"Phys. Rev.," Nov.

MAGNETIC SUSCEPTIBILITIES.

A large accumulation of material from which the author draws some conclusions; it has reference more particularly to air, water, etc. He finds that bodies which have the smallest atomic volume are also the most strongly paramagnetic; also that the susceptibility of diamagnetic solids is independent of the strength of the field.—Koenigsberger. "Wied. Ann.," No. 12; abstracted briefly in Lond. "Elec.," Dec. 23.

MAGNETIC STEEL.

A reproduction of the magnetic curves of Saville steel, made in Sheffield, giving the results of tests made by the German Reichsanstalt. The material compares fairly well with the best known tungsten steel—that is, the Allevard steel—for permanent magnets. While the latter has a higher coercive force, the former may make the more powerful, although less stable, magnets.—Lond. "Elec. Rev.," Jan. 6.

REFERENCES.

Calculation of Conductivity of Solutions.—Two papers have recently been published, one by Archibald on the calculation of the conductivity of aqueous solutions containing the double sulphate of calcium and potassium and of mixtures of equi molecular solutions of zinc and copper sulphates; the other by McKay, on the calculation of the conductivity of aqueous solutions of potassium and magnesium sulphate. Both are based on the researches of MacGregor and on his suggestions.—"Transactions of Nova Scotia Institute of Science," Vol. 9.

Printing By X-Rays.—A brief description of the Izambard process of printing by means of X-rays, the inventor claiming that he has succeeded in producing a machine for this purpose.—N. Y. "Elec. Eng.," Jan. 12.

Electro-Chemistry and Batteries.

ACCUMULATORS FOR TRACTION.

In a brief reference to the accumulators recently exhibited at the Automobile and Cycle shows in Paris, Mr. Robert, in "L'Elec.," Dec. 31, calls attention to the question of the maintenance of the cells. There are two solutions of the problem of maintenance, one is to make the weight of the accumulators as small as possible and recognize the fact that the life is limited; the other is to make the life of the cells as great as possible, which means that the weight of the batteries, and therefore that of the whole vehicle, is increased quite appreciably. He believes that the first solution is the preferable one, assuming that the cost of renewing the batteries is sufficiently moderate. The cost of maintenance is made of two parts, one the cost of replacing the plates and the other the running costs of taking care of the cell; the latter is about the same for a light as for a heavy battery. If in taking care of the cells it is found that one of them begins to show weakness it is very necessary to immediately replace it with another cell charged to the same degree as the rest of the battery; in such a case the heavy accumulator has the advantage, as the faulty cell often requires only to be cleaned in order to bring it up to its normal condition; but if it is necessary to take the cell apart it is generally preferable to replace the whole set of plates, as an accumulator is generally injured by taking it apart and assembling it again; in such cases the advantage is with the lighter types, provided they are sufficiently cheap. Among others he mentions the Pingault accumulator, which can deliver 70

amperes during an hour at about 30 volts, the total weight of the battery of cells being about 176 pounds. The negatives in these are made of zinc, thus diminishing the weight and increasing the voltage, but they require special care in charging and they are therefore not practical for vehicles, for which purposes the negative plates are made of lead. Automobiles have now been constructed the efficiency of which he considers remarkable, if the official reports of the recent trials in Versailles are correct. Among these there were some which required only 85 watt hours per ton km on a heavy course and 75 watt hours on a normal course.—Robert. "L'Elec.," Dec. 31.

AUTOMOBILE ACCUMULATORS.

A brief description, with a full table of data, of the accumulator made by the company in France, which corresponds to that making the chloride accumulator in this country, is given by J. Reyval in "L'Eclairage Elec.," Dec. 31. It is not intended to be extra light, but is considered to be a good commercial form. The negative plates are made with pastilles of chloride of lead as usual in that type, while the positives are Planté plates, made of bands of lead united to form plates. At a discharge rate of 70 watts the capacity is 250 watt hours, the time of discharge 3.5 hours, the rate 4.1 watts per kg of complete cell, the capacity 14.7 watt hours per kg of complete cell, and the complete weight 17 kg. No illustrations are given.—Reyval. "L'Eclairage Elec.," Dec. 31.

PRODUCTION OF METALLIC LITHIUM.

Mr. Guntz, in a recent article in a German chemical journal, describes the following process by which he obtained metallic lithium: A mixture of equal weights of chloride of lithium and chloride of potassium is fused and electrolyzed, the anode being graphite and the cathode an iron wire in a porcelain tube open at the bottom. After the electrolysis this tube is closed at the bottom with an iron spatula and taken out, and after the fused electrolyte has solidified, the lithium can be poured out.—Guntz. "Zeit. Anew. Chemie," 158; noticed briefly in the "Zeit. f. Elektrochemie," Dec. 29.

REFERENCES.

Ozone.—A short article criticising unfavorably the claims and processes of an electric refining and purifying company in Philadelphia, using the Pridhan process of generating ozone, descriptions of which were published in the daily papers some years ago.—Andreoli. "L'Elec.," Dec. 24.

Ionization.—A paper on the relation of the surface tension and specific gravity of certain aqueous solutions to their state of ionization.—Archibald. "Transactions of Nova Scotia Institute of Science," Vol. 9.

Competitive Trials of Automobile Accumulators.—A translation of the programme of the competition, an abstract of which was given in the "Digest" Jan. 7.—Lond. "Elec. Rev.," Jan. 6.

Extraction of Gold and the Cyanide Process.—A summary of the subject.—Rose. "Science Progress," 7, p. 307; abstracted briefly in the Lond. "Elec. Rev.," Dec. 30.

Recovery and Refining of Nickel.—A reprint of the article noticed in the "Digest" Jan. 14.—Cowper-Coles. N. Y. "Elec. Rev.," Jan. 18.

Units, Measurements and Instruments.

A METHOD OF MEASURING HIGH RESISTANCES.

A method of measuring high resistances with a d'Arsonval galvanometer is described by Schuerr in "L'Eclairage Elec.," Dec. 31, it being an abstract of a paper from the "Jour. de Physique," Oct. The principle of the method is described as follows: "In the d'Arsonval galvanometer the oscillation of the coil becomes periodic if it is closed on a sufficiently high resistance, and the period can be considered invariable for values of this resistance beyond a certain limit. When the latter condition is fulfilled the product of the total resistance of the circuit by the difference of the logarithmic decrements which correspond to the given resistance, and to an infinite resistance, is also constant. Consequently this product being known for a given galvanometer, the measurement of the resistance consists simply in the determination of two decrements." For a coil of 220 ohms the period was found to be constant for a resistance varying between 5000 ohms and infinity. In applying the method a current is sent through the coil to give it an initial deflection; this current is then stopped and the circuit of the coil closed through the resistance to be measured. A certain number n of periods is then counted and the deviation at the end of the n'th period is read off. He tested the method of applying it to measuring the resistances of streaks of graphite, and compared the results with those found by other methods. From 5000 ohms up the accuracy of the method is said to be one one-hundredth. The method may also be applied to measuring the resistances of electrolytes and the results of such a test are described.—Shuerr. "L'Eclairage Elec.," Dec. 31.

MEASURING HIGH POTENTIALS WITH LOW-POTENTIAL INSTRUMENTS.

Two methods by which the range of an electrometer or ballistic galvanometer may be almost infinitely extended, are described by S. J. Barnett in the Lond. "Elec. Rev.," Jan. 6. The first consists in applying the whole difference of potential to the terminals of two condensers in series and then measuring the fall of potential between the plates of one of them, from which and from the known capacity the whole difference of potential can be calculated. In a test which he made the ratio of the two condensers was as 75 to 1, thus enabling a Kelvin quadrant electrometer to be used for measuring 30,000 volts. The second method is an inversion of Faraday's well-known method of comparing capacities. The ratio of the capacities of two condensers being known, the initial potential can be calculated from the final, which may be made as slow as desired by suitably selecting the condensers. The voltage to be measured is applied to the plates of one condenser, which is then insulated and immediately connected in multiple with the other, thereby reducing the original difference of potential by increasing the capacity by the addition of the second condenser, to which latter the electrometer of galvanometer is then attached. The formulas for both methods are given. The second method has the great advantage over the first in that it avoids completely the troublesome effects of absorption and leakage, the whole process being practically instantaneous.—Barnett. Lond. "Elec. Rev.," Jan. 6.

THEORY OF THE INDUCTION COIL.

A simple theory of the induction coil has been worked out by the German physicist Walter, who also made a number of experiments, the conclusions from which are given briefly in the Lond. "Elec. Rev.," Dec. 30. The experiments established the fact that the capacity and self-induction of the secondary in large coils is sufficiently great to cause well-marked and persistent oscillations, and that to get the best results the primary and secondary circuits should be syntonized. Large and small coils must therefore be constructed on quite different principles. He concludes that no simple formula can be given for caluclating the dimensions of large coils, but his investigations point out certain directions in which the construction might be improved. It is desirable, for instance, that the method of winding and the choice of the dielectric should be such as to reduce the capacity of the secondary to a minimum, as the frequency of the oscillations in the primary is thus kept as high as possible. It is also of great importance that a magnetic material should be used having the highest possible susceptibility and the smallest possible hysteresis, in order to get the most rapid oscillations, with the least possible loss of energy.—Walter. Lond. "Elec. Rev.," Dec. 30.

LOW-VOLTAGE STANDARD CELL.

In order to provide a simple means for testing the much-used Edison-Lelande cell; Mr. McIntosh endeavored to find a cell which can be used as a standard and which has a low e. m. f. of about 0.5 volt. He describes his researches in the "Jour. of Physical Chemistry," 2, p. 185, a brief abstract of which is given in the "Zeit. f. Elektrochemie," Dec. 22. He found that the following gave constant values and can be used as standard cells: Copper—Copper sulphate + mercury sulphate — mercury; the e. m. f. is $0.3613 + (16.5 - t)\ 0.0006$. Also the following: Lead—Lead chloride — mercury chloride — mercury; the e. m. f. is $0.5382 + (t - 21)\ 0.0006$ volt; t evidently refers to the temperature in centigrade degrees.—McIntosh. "Jour. of Physical Chemistry," 2, p. 185; abstracted in "Zeit. f. Elektrochemie," Dec. 22.

REFERENCES.

Rapid Rotary Break.—An abstract of a French Physical Society paper describing a break capable of making 1000 interruptions per second, and having a duration of contact of at least one-seven-hundred-and-fiftieth of a second.—Guilloz. "L'Ind. Elec.," Dec. 25, and "L'Eclairage Elec.," Dec. 24.

Mutual Action of Two Circuits and the Determination of Dielectric Constants.—An abstract in French of the article noticed in the "Digest" Jan. 7.—Erskine. "L'Eclairage Elec.," Dec. 31.

Telegraphy, Telephony and Signals.

LOUD TRANSMISSION OF SOUND.

Mr. Dussaud, in a recent French Academy paper, published in "Comptes Rendus," Dec. 5, and abstracted briefly in Lond. "Elec.," Dec. 23, describes some interesting investigations made to find the best means of intensifying the sounds of a combined microphone and telephone receiver. He produced a steady sound by means of a tuning fork in front of a very sensitive microphone, and at the receiver end the circuit was divided into four branches, each actuating a separate telephone membrane. It is said in the abstract that he found that the more numerous the receivers were, the louder was the sound, a statement which evidently requires some modification. It was also found advantageous to collect the vibrations from both sides of the membranes. He used collecting tubes, all leading into a resonator of the shape and size of a human mouth. In this way he reproduced the sound of wind instruments and the human voice in a large hall accommodating 1000 persons, with such loudness that they could be heard in every part of the hall. On the State telephone system of Geneva communication was established between two subscribers in which ordinary speech could be heard in every part of the room, and as only two Leclanche cells were used, the increased efficiency is claimed to be due entirely to the new arrangement.—Dussaud. "Comptes Rendus," Dec. 5; abstracted in Lond. "Elec.," Dec. 23.

LARGE CABLE PROJECT.

In an editorial in the Lond. "Elec.," Dec. 23, attention is called to a letter to the Colonial Secretary by Sir Sandford Fleming, abstracted in another part of that issue, in which he advocates a cable scheme which shall be entirely British and owned by the State. The suggestion is that the British, Canadian, Australian and New Zealand governments should jointly lay down cables at their own expense from Western Canada via the Pacific to Australasia, and then by way of India, Ceylon and the Cape, to Bermuda and Halifax. The cost is estimated at from $25,000,000 to $30,000,000. The

London "Times" questions whether "the game is worth the candle." According to the latter paper, the Canadian Government has offered to contribute an equal share with the Imperial Government of the cost of a Pacific cable, the joint obligation not to exceed 5-9 of the whole cost, the Australasian colonies having undertaken to contribute the balance. This is not the same scheme as the one recommended by Fleming, and the London "Elec." remarks that it stands probably as little chance of acceptance by the British Government. —Lond. "Elec.," Dec. 23 .

REFERENCES.

Interurban Telegraphy in Italy.—A series of articles by Brunelli, of the Government Telegraph Department, is begun in the "Jour. Telegraphique," Dec. 25, in which he intends to give a description of the apparatus to be used and the instructions regarding the service. The system is to enable communication to be established not only between two stations in different cities but between a subscriber in one city and another in the other.—"Jour. Telegraphique," Dec. 25.

Wireless Telegraphy.—Tests were recently made in Pola, Austria, with an improved Marconi system of wave telegraphy, which, according to a note in the "Elek. Zeit.," Jan. 5, enabled the presence and the course of a vessel six to seven miles distant to be determined. The name of the inventor of the system is Schefer, but no further information is given.—"Elek. Zeit.," Jan. 5.

Magnetic Space Telegraphy.—In the continuation of the reprint of Lodge's paper (see "Digest" last week), some of the improved forms of the detectors at the receiving station which were made and tried are described with the aid of illustrations, among which are a tone telephone, a coherer and a vibrating coil telephone.—Lond. "Elec.," Jan. 6.

Telephone Exchange for Brussels.—A brief, illustrated description of the new telephone exchange, which will soon be opened by the Government, in Brussels, Belgium, and which is said to be one of the largest exchange buildings in the world.—N. Y. "Elec. Eng.," Jan. 12.

Central Telephone Stations in Paris.—The first part of a long, well-illustrated translation in abstract of the article noticed in the "Digest" July 30.—la Touanne. "Elek. Zeit.," Jan. 5.

Signaling Apparatus.—A brief, illustrated description of the electric signaling system recently installed at Atlantic City by the Weather Bureau.—"West. Elec.," Jan. 14.

Miscellaneous.

REFERENCES.

Influence of Electricity on Animals.—A translation in abstract from "La Nature" of a short article describing the effect of an electric current on microscopic animal organism, some of which tend to move to the positive and others to the negative pole of the source. —Coupin. "West. Elec.," Jan. 14.

Electrical Trade in Argentina.—A short description of some installations of the electrical trade with that country.—Rei. "West. Elec.," Jan. 14.

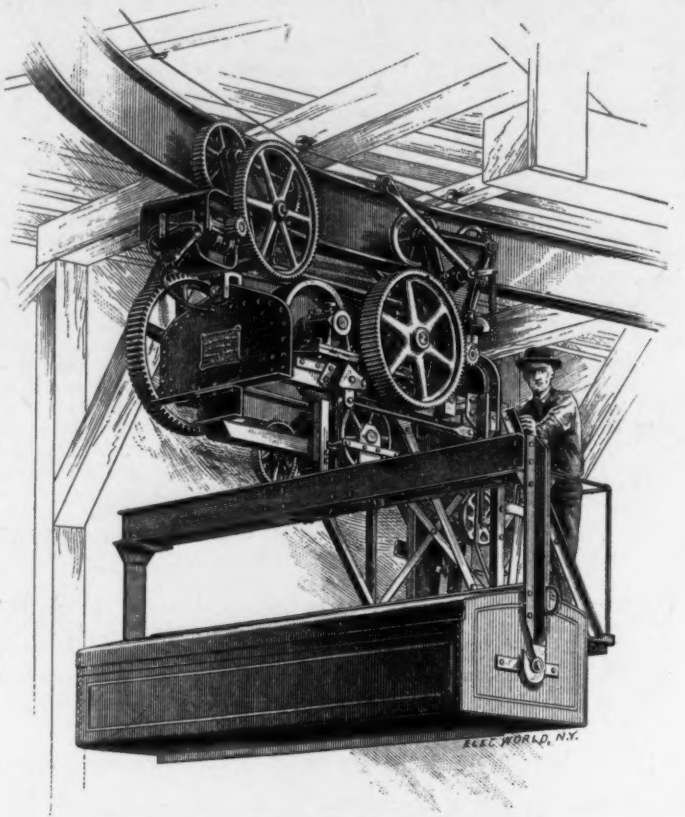
Electric Furnaces.—Brief, well-illustrated descriptions of various forms, taken from patent specifications.—Richard. "L'Eclairage Elec.," Jan. 7.

Progress in 1898.—An article reviewing the progress in electrical industries during the past year.—Reyval. "L'Eclairage Elec.," Jan. 7.

Expiring Patents.—A list of the British patents of interest to electrical engineers expiring this year.—Lond. "Elec.," Jan. 6.

A Novel Overhead Electric Traveling Crane.

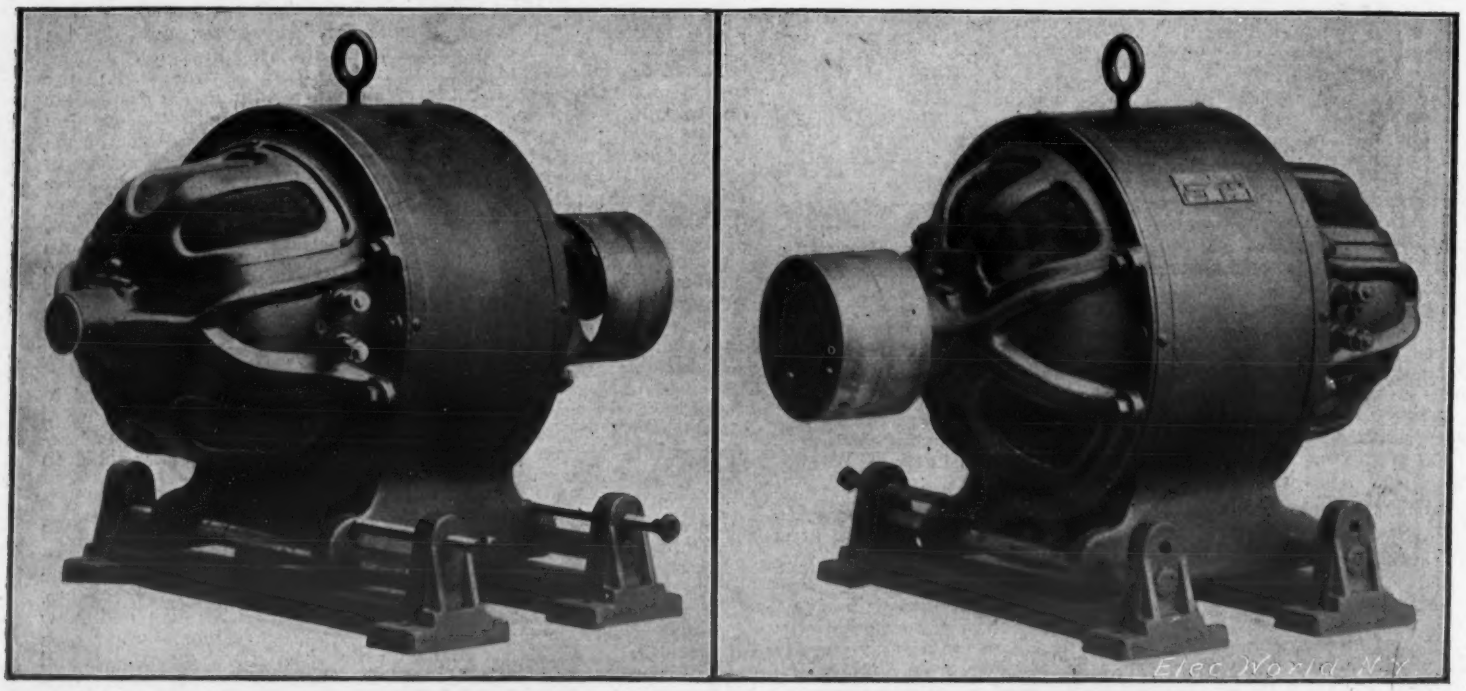
An overhead traveling crane which has a greater range of application and action than the ordinary overhead, bridge type is manufactured by the Brown Hoisting & Conveying Machine Company, Cleveland, Ohio. The accompanying illustration, which is taken from "The Iron Age," shows the crane to be supported and run on the lower flanges of an I beam. The current is taken from the overhead conductor by means of a short trolley arm at one end of the machine, the motor being located just below the I beam at the other end. The crane is provided with swivel trucks, and can round a curve of 16-foot radius, with full load. The speed of travel is 200 feet per minute, with full load, and the hoisting speed 20 feet per minute.



An Improved Overhead Traveling Crane.

This machine was built for the Newburgh Reduction Company, of Cleveland, but the Brown Company has constructed several other similar ones for various other concerns.

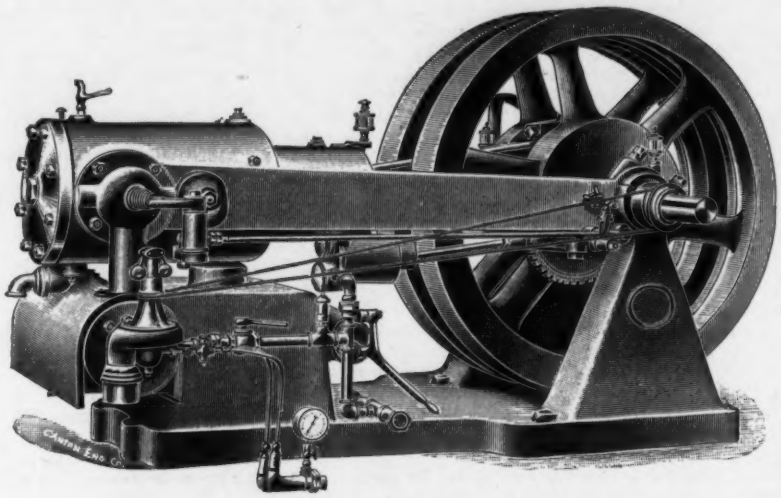
It is evident that such a machine, provided with a suitable runway system, overhead switches and turntables, can travel all over a plant and from building to building. It is stated that these cranes can be made to run at high speeds.



Two Views of the Commercial Iron Clad Motor.

The Commercial Iron Clad Motor.

The motor of which views are given on the preceding page is built by the Commercial Electric Company, of Indianapolis, Ind., for two speeds, and is applicable to a variety of uses. The magnet frame, field cores and pole shoes are made of steel, thus giving a magnetic circuit of high permeability. The cast iron end casings are provided with ample ventilating holes, which are screened to prevent the entrance of flying particles of foreign substances. The motor runs on a steel shaft in self-oiling bearings with bronze linings, which may be reversed with facility. The carbon brush holders are of simple construction, and it is stated that the machine runs without sparking, thus requiring little attention. In the casing large lids are provided above and below the commutator to admit of easy access to the brushes. The belt-tightening device is an ingenious arrangement. It permits the attachment of the motor to the ceiling in an inverted position, thus avoiding the necessity of a platform. In this position the belt-tightener may be adjusted as easily as if the machine were placed upon the floor, since there are no suspension bolts or nuts to loosen in order to move the frame. When used in this way the motor can be directly belted to elevator machines. The Commercial Company makes a special reversible motor and controller for use in such applications. On the floor or on the ceiling the motor runs equally well.



OIL ENGINE OF NEW DESIGN.

A New Internal Combustion Motor.

Since the successful introduction of gas and gasoline engines experimenters have been working on internal combustion motors adapted for using as fuel the heavier and safer constituents of petroleum, such as the grades of kerosene or carbon oil commonly burned in house lamps. Such oils do not evaporate upon exposure to the atmosphere, as do gasoline, naphtha, etc., and so, not giving off explosive gases, are highly desirable in many places where the very dangerous nature of the lighter oils renders their use undesirable or prohibitive. Until quite recently certain obstacles met with prevented the successful operation of engines using safe oils, but it is now claimed that these have been overcome and the success of the safety oil engine is an accomplished fact.

The Aultman Company, of Canton, Ohio, has recently taken up the manufacture of the Priestman safety oil engine, which, aside from the character of fuel used, differs from gas and gasoline engines in several important respects. The most striking feature is, perhaps, the position of the flywheels, which are mounted between, instead of outside, the main bearings, as is the general practice. This method of construction is known as the "straight line" principle, and has been highly commended by prominent engineers. As the power transmitted by the connecting rod is absorbed by the flywheels without being first transmitted through the main bearings, the latter are relieved of a tremendous twisting strain. This fact is evidenced by the minimum of wear and of lubrication required. The only parts about the engine that are mechanically operated are the exhaust valve, the governor, a small power pump which is operated by an eccentric for pumping the oil, and a little device for making and breaking the electric battery circuit.

Only high test, safe petroleum, such as used in common house lamps, is employed for fuel.

The method of operation is as follows: A fine kerosene spray is injected into the chamber underneath the cylinder head. Here this spray is mixed with the proper proportion of air for supporting combustion and the mixture heated by the hot exhaust gases, which are made to pass through an annular space surrounding this mixing chamber before being expelled into the atmosphere. The heated charge of oil spray and air is then drawn through the inlet valve into the cylinder by an outward stroke of the piston. The inlet valve is not mechanically operated, but is opened automatically, by suction, or, in other words, the pressure of the atmosphere. The return stroke of the piston compresses the charge, which is then ignited by an electric spark from an ordinary battery. During the succeeding return stroke of the piston the exhaust valve is held open mechanically, and the dead gases are swept out of the cylinder. This cycle of events embraces two revolutions of the flywheel.

The chief departure from the gas engine principle of operation is in the treatment of the fuel, a considerable portion of which, if not all, is burned as a liquid spray instead of as a gas. A very small portion of the oil spray within the cylinder coats the walls of the latter, and so perfectly lubricates them that no other means is ever provided for the purpose. The oil, which is kept in a tank, is pumped into the spray maker under a pressure of about 8 pounds. The oil consumption is about 1¼ pints per brake horse-power per hour. Looking at the question of consumption in another way: every time an engine receives an impulse it requires the burning of only about 1½ drops of oil to produce each horse-power.

The steam engine method of governing, that is, by throttling the charge, is employed, and impulses are taken regularly whether the engine be running empty or fully loaded, each charge of oil spray being exactly proportioned to the load carried. The excellent speed regulation of the engine especially adapts it for electric lighting and a steady incandescent light can be obtained without the use of countershafting or extra balance wheels.

It is pointed out as an interesting fact, and one possibly not generally known, that by using a given quantity of oil in the Priestman engine for operating incandescent electric lights more illumination can be secured than if the same quantity of oil were burned in common house lamps. It may also be of interest to know the actual amount of work that can be secured from a small quantity of kerosene burned in a Priestman engine that is operating some of the most common classes of machinery. In electric lighting it is stated that one pint of kerosene will run eight 16-cp incandescent lights, or one 1,600-cp arc light for one hour. When operating an ice machine a pint of oil will produce about 200 pounds of ice at 15° F. from water 70° F. If attached to a hoist 100 tons can be lifted four feet, or one ton can be lifted 400 feet by one pint of oil; and when used for pumping the expenditure of this small quantity of oil will raise 1,000 gallons of water 96 feet high. In computing these figures, due allowances have been made for the average inefficiencies of all apparatus employed.

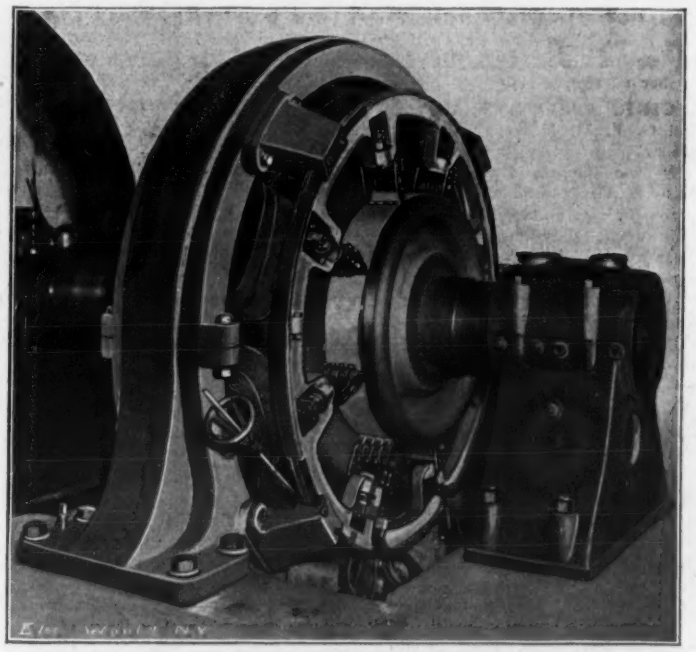
As the Priestman engine is very simple in its method of operation, and is entirely automatic in its action, it is admirably suited for places where there is desired a cheap, safe and reliable motive power, which can be satisfactorily handled by unskilled labor, with the least attention.

The Aultman Company has recently added a number of improvements to the engine, among them being an air storage system whereby engines can be started without recourse to any preliminary hand pumping or turning of the flywheels.

A Siemens & Halske Generator of New Design.

The accompanying illustration is reproduced from a photograph of the first generator installed in the new printing establishment of W. B. Conkey, of Hammond, Ind. The distribution of power of this plant is entirely electrical, and was described in THE ELECTRICAL WORLD of November 12, 1898, by Mr. George A. Damon, under the title "The Electrical Equipment of a Model Printing Establishment."

The generator, which was built by the Siemens & Halske Electric Company of America, is a 225-volt, eight-pole, compound-wound machine, rated at 100 kilowatts when running at 125 r. p. m. It is direct-coupled to a Corliss engine, and will eventually be one of the three similar units all connected to two Corliss engines on the Arnold system. For this purpose the armature shaft is a hollow sleeve through which a solid connecting shaft between the engines and couplings can be run. The illustration shows many features of the new designs of Siemens & Halske machinery, which will appeal to those engineers who admire in a machine simplicity, solidity and the grace that characterizes perfect adaptation to its purpose. The solidity of the outboard pedestal, the graceful curves of the field yoke, the substantial lugs supporting the rocker ring, the continuity of whose periphery is unbroken at the brush holders, the running of the brush-holder leads inside the rocker ring and through the openings in the latter at the two lower holders, the improved form of reaction brushes, etc., all evidence the care taken in the draughting-room where this machine was laid out.



GENERATOR OF NEW DESIGN.

NEWS OF THE WEEK

Financial Intelligence.

THE CINCINNATI EDISON ELECTRIC LIGHT COMPANY has increased its capital stock from $1,285,000 to $2,000,000.

THE CLEVELAND TELEPHONE COMPANY, Cleveland, Ohio, has increased its capital stock from $2,000,000 to $3,000,000.

THE EDISON ELECTRIC ILLUMINATING COMPANY of Boston has declared a dividend of 2 per cent., payable on February 1.

EDISON ELECTRIC ILLUMINATING of New York made a notable advance on January 19, which, on transactions aggregating only 500 shares, sold at 197½. This is the highest price at which the stock had ever sold up to that time, the highest previous figure being 195.

THE WESTINGHOUSE MACHINE COMPANY.—The stockholders of the Westinghouse Machine Company will, on March 1, vote on the proposition to increase the stock of the company from $1,500,000 to $3,000,000, preparatory to increasing the capacity of the plant at East Pittsburg.

AMERICAN BELL TELEPHONE stock reached high water mark in Boston during the past week. On January 17 it reached 313, a gain of 13 points over the previous closing quotation, and on January 18 it reached 316, a further gain of 3 points. This was the highest price recorded, and the stock dropped after that, reaching 310 on Friday.

MORTGAGE.—A mortgage of $16,000,000 to cover the property of the reorganized Brooklyn Elevated Railroad has been drawn up by Receiver Uhlmann. First mortgage bonds will be issued, of which $11,890,000 will be used to redeem the old bonds of the Brooklyn Union and Seaside & Brooklyn Elevated Railroad companies; $1,000,000 will be held in reserve for electrical equipment and $3,000,000 for power houses and improvements. The stock of the reorganized company consists of $5,000,000 preferred and $13,000,000 common. $3,800,000 of the preferred and all of the common stock have been issued.

Special Correspondence.

New York Notes.

A POOR OPINION OF WELSBACH BURNERS.—At a recent meeting of the City Council a councilman from Brooklyn Borough offered a resolution providing that all electric lights in the streets of that borough be abolished, and that Welsbach burners be substituted therefor. It was suggested by another Brooklyn councilman that Manhattan Borough be included in the provisions of the bill, "so that the whole city might be in darkness."

MEDALS AWARDED FOR TECHNICAL PAPERS.—At the forty-sixth annual meeting of the American Society of Civil Engineers, which was held in the society's building at No. 220 West Fifty-seventh street, this city, the Norman medal was presented to B. F. Thomas for his paper on "Movable Dams," and Henry Goldmark received the Thomas Fitch Roland medal for his paper on "The Power Plant, Pipe Line and Dam of the Pioneer Electric Power Company at Ogden, Utah." This plant was described in THE ELECTRICAL WORLD of October 16, 1897.

ELECTRIC RAILWAYS AND ELECTRIC LIGHTING IN CUBA.—Colonel G. B. M. Harvey, who represents one of the syndicates formed to acquire railroad, lighting and other concessions in Cuba, has just returned to this city from Havana. During his stay in Havana Colonel Harvey purchased a railway system there, connecting the Regla ferry with the suburbs. He states that he also obtained rights for constructing electric trolley roads in the streets of the city, besides purchasing the street-lighting systems of Santiago, which is now lighted with oil lamps. The syndicate represented by Colonel Harvey proposes to erect an electric light plant there.

NEW ELECTRIC LIGHT COMPANY IN NORTH HUDSON, N. J.—It is reported that a movement is on foot to organize a new electric light company for the purpose of competing with the North Hudson Heat, Light & Power Company, formerly the Hudson Power Company, of Hoboken. The latter named company now enjoys a monopoly of street lighting in Hoboken and North Hudson towns. Mr. A. K. Bonta has resigned as general manager, treasurer and secretary of the North Hudson Company. Mr. Bonta was also superintendent of motive power of the North Hudson County Railway Company, which recently passed into the hands of the North Jersey Street Railway Company. This position he has also resigned.

TO TEST POWER BRAKES FOR SURFACE CARS.—The State Railroad Commission is endeavoring to secure the equipment of street surface electric and cable cars with power brakes. In view of the great weight of the cars now in use and in the increased speed with which they are propelled, the commission deems the old style brakes insufficient to properly control the cars. To procure a satisfactory brake and with the intention of recommending its use the commission has called upon inventors to prepare for a public test to be given under the auspices of the commission on one of the lines of the Metropolitan Street Railway Company of New York, at a date to be fixed when a sufficient number of applications for participation in the tests has been received.

RUMORS REGARDING THE MANHATTAN ELEVATED RAILWAY.—It was reported one day last week that a sufficient number of shares of Manhattan Elevated Railway stock had come into the possession of the Vanderbilts or the Metropolitan Street Railway Company to give them control of the elevated road. There has been a general impression for some time that a big deal of this kind was pending, and the fact that Mr. Alfred Skitt, a former New York Central man, has been appointed vice-president of the Manhattan Elevated Railway Company is considered significant in this connection. Various rumors connecting the names of the Metropolitan Street Railway Company and the Manhattan Elevated Railway Company have been in circulation in the recent past, but it has been impossible to obtain any confirmation of the reports.

MR. THOMAS A. EDISON has been greatly annoyed of late by the actions of irresponsible persons who organize so-called Edison companies or establish themselves as his agents without his authority. In many cases where people were duped by the alleged "agents" they wrote to Mr. Edison for redress. The annoyance became so great that Mr. Edison decided to put a stop to the practice, and has put the matter in the hands of the Federal authorities. Two persons calling themselves Baron and Baroness Debara were arrested at Jacksonville, Fla., recently as a result of Mr. Edison's determination to stop the practice of using his name without authority, and other so-called representatives of Mr. Edison are being watched. One of them, a man calling himself George B. Henschell, disappeared from the scene of his operations in Chicago when the authorities undertook to find him.

AMERICAN TELEGRAPHERS TO HONOR THE MEMORY OF VOLTA.—It is proposed to send a representative telegrapher to Como, Italy, to represent the American telegraphers on the occasion of the celebration, on May 30, 1899, at Milan and Como, to commemorate the 100th anniversary of Volta's historical invention of the electric pile. The occasion is to be fittingly marked by the telegraphers of Italy by placing a bronze crown at the foot of the statue of the celebrated physicist. They have invited telegraphers all over the world to participate in the interesting occasion by representation and contributions for the purpose of sharing in the cost of the memorial. The Italian Telegraph Administration has given its indorsement to the movement and telegraph departments of other European governments are also lending their aid. It is the desire to give the affair an international character. An exposition will be held at Como from May to the end of October, this year, to commemorate the centenary of the discovery of the Voltaic pile. Mr. Walter C. Burton, a chief operator of the Western Union Telegraph Company at 195 Broadway, New York, has been named to represent the American telegraphers on this interesting occasion. He is a man of marked ability and character and it is thought will represent the American telegraphic fraternity with dignity and honor. Mr. Francis W. Jones, electrical engineer of the Postal Telegraph Company, New York, has consented to act as treasurer of the subscription fund to defray the expenses of the American delegate.

TO REDUCE TELEPHONE RATES.—Two bills were introduced in the Legislature at Albany on January 19 to provide for a reduction of telephone rates. One of them was introduced by Assemblyman O'Connor, of New York, and provides for the regulation of charges of telephone messages in cities of one million inhabitants or over, to general users in commercial and professional pursuits at $144 per annum for 2,000 messages or less, and 5 cents for each additional message in excess of the 2,000. It also provides that all users who pay an annual aggregate amount of $1,000 or more be entitled to a reduction of 10 per cent. from the above rates. For other than professional or commercial pursuits the company is allowed to make contracts for 1,000 messages or less at the rate of 8 cents per message. The other bill was introduced by Assemblyman Cain, of Brooklyn, and contains, among other provisions, the following schedule of charges: In cities of 1,000,000 inhabitants or over, not to exceed $85 per annum; cities of 500,000 and less than 1,000,000, not to exceed $75 per annum; cities of 100,000 and less than 500,000 inhabitants, $50; cities of 50,000 and less than 100,000 inhabitants, $36; cities and places of 8,000 and less than 20,000 inhabitants, $30, and in cities and places of less than 8,000, $27. The charges at public pay stations are not to exceed 10 cents for the first five minutes after a connection is made and 5 cents for each five minutes thereafter.

THE BROOKLYN TROLLEY CONSOLIDATION.—It is stated that the firmness of Mr. Patrick H. Flynn, who is holding out against the consolidation of the Nassau and Brooklyn Rapid Transit systems, may lead the Flower syndicate to change its plans somewhat with reference to the merging of the two Brooklyn railway companies. It is stated that the new managers of the two systems are now at work on a plan to lease the Nassau to the Rapid Transit Company, which will have the same effect as consolidation except that it will make the finances a little more difficult to handle. The combined companies will give transfers between their various routes and it is pointed out that the people will thus be gainers as a result of the consolidation. A special meeting of the stockholders of the Brooklyn Rapid Transit Company has been called for February 11 to vote on the proposition to increase the capital stock of the company from $20,000,000 to $45,000,000 in order to provide the means of absorbing the Nassau Electric Railroad Company. Treasurer Williams, of the Brooklyn Rapid Transit Company, is reported to have said that the extra $25,000,000 capital will not all be devoted to the purchase of the Nassau Railroad. It is stated that from $8,000,000 to $10,000,000 of the new stock will be used to conclude the purchase, while the remainder will be held in the treasury of the Rapid Transit Company for contingencies which are believed to include the ultimate absorption of the elevated roads in Brooklyn. It is rumored that ex-Governor R. P. Flower and his associates are working steadily with the view of consolidating the remaining railroads in Brooklyn, including the Elevated, with the Rapid Transit and Nassau Companies. A syndicate, according to report, has already been formed for this purpose. The new company will buy all of the companies and pay for them partly in bonds and partly in stock of the new corporation. The capitalization of the new concern, it is said, will be about $100,000,000. It is pointed out that under consolidation and the elec-

trical equipment of the elevated railway lines—the power being furnished by the surface railroad companies—operating expenses will be enormously reduced, and the system will pay dividends almost from the start. Although no definite information regarding these reports can be obtained at present, the fact that large economies will be possible with the elevated roads operated in conjunction with the surface lines gives color to the current belief that the consolidation will be effected at an early date.

THE SALE OF THE NEW YORK EDISON COMPANY TO THE WHITNEY SYNDICATE.—On January 19 Spencer Trask & Co., Vermilye & Co. and the Central Trust Company issued a circular to the owners of stock in the Edison Electric Illuminating Company, of New York, announcing that they had entered into an agreement with the State Trust Company for the sale of the Edison stock to the New York Gas & Electric Light, Heat & Power Company the syndicate recently formed by William C. Whitney, W. L. Elkins, P. A. B. Widener, Thomas Dolan, Thomas F. Ryan and others for the consolidation of the lighting interests on Manhattan Island. The agreement will be operative on the assent of the owners of 55 per cent. of the stock being granted on or before February 25, 1899, the assenting owners to have the privilege of selling to the syndicate at the same rate, namely, 220 per cent. of the par value of the old stock, payable in four per cent. fifty-year bonds of the syndicate at par, with a standing offer from Vermilye & Co. to redeem these bonds at 85 per cent. and accrued interest. The issue of the syndicate bonds is to be limited to $21,000,000, and they will be secured by a first lien on the Edison stock by the deposit of $4,000,000 in cash with the trustee, the Central Trust Company, as well as by a second mortgage upon the property and franchises of the syndicate, which are, however, subject to a first mortgage securing $15,000,000, of which $11,500,000 have already been issued for properties taken up. Of Edison stock there are now outstanding shares with a par value of $7,938,000, which, at 220, will bring about $17,500,000, the company's property being subject to mortgages aggregating $6,500,000, making the total valuation of this property under the sale about $24,000,000. The plant account of the company is listed in its annual report of February 8, 1898, at about one-half of this sum, or $12,000,000. The property is a most successful one financially, the same annual report giving the total net income for the year 1897 at $1,117,497, of which over $476,000 was declared as dividends, or 6 per cent. on the capital outstanding. The net earnings for the eleven months ending December 1, 1898, were $1,134,000, an increase of $156,000 over the corresponding figure of the previous year. The Edison Company of New York is famous as one of the most progressive and successful central station interests in the country. It started supplying current from the famous old Pearl Street station in the year 1882, and only once during the seventeen years that have followed has the supply of current to the underground system been interrupted, namely, at the time when the original station was burned. It now operates four low-tension stations, one storage-battery substation and controls several other companies supplying alternating systems, the total load connected June 1, 1898, being the equivalent of 837,366 incandescent lamps, including breakdown connections. The total mileage of the underground system was at the same date 222 miles of tubing. The Duane Street plant is the largest and most famous of central stations of the type known as "on edge." It contains engines with an aggregate rated output of 11,800 horse-power, among them two quadruple-expansion units of 2500 horse-power each, and dynamos with an aggregate output of 7600 kilowatts. The three storage batteries of the company have an aggregate capacity of 14,600 ampere hours at a ten-hour discharge rate. The peak of the load of the entire system amounts to about 100,000 amperes. The high economy obtained in the Duane Street station compared with that of the smaller generating stations has led the company to install rotary converters for transforming direct current to alternating, which is in turn raised to high pressure, transmitted uptown, stepped down and reconverted into direct current. This equipment is now in service to give data on the cost of current so transmitted as compared with that generated in the smaller stations. The $25,000,000 company, or the Whitney syndicate, as it is known, was organized by stockholders of the Metropolitan Street Railway Company, which has practically free rights to the use of the streets for the laying of conduits, but has no right under its charter to distribute current for light and power. The high conduit rentals necessarily paid by the older companies to the city gave the Metropolitan stockholders a splendid opportunity to form an allied company, take over the existing lighting companies and operate a consolidated system with the new conduits free of rent, which they proceeded to do. They have already obtained control of the Mt. Morris Electric Light Company and the Consolidated Telegraph & Electric Subway Company and the Block Electric Light & Power Company, the latter a small concern supplying a few buildings in its immediate neighborhood, but with an enormous unlimited perpetual franchise. These holdings account for the above mentioned issue of $11,500,000 in bonds.

PHILADELPHIA NOTES.

THE KEELY MOTOR INVESTIGATION.—The Philadelphia "Press" recently undertook to unravel the mystery of the Keely motor matter, and with this object in view instituted a thorough search of the premises which until lately held the Keely apparatus. The investigators were Carl Hering, a consulting electrical engineer, of this city; Prof. Arthur W. Goodspeed, assistant professor of physics of the University of Pennsylvania; Prof. Lightner Witmer, professor of experimental psychology at the University of Pennsylvania, who, it is stated, entered upon the investigation as a study of delusions; and Dr. M. G. Miller. Mr. Clarence B. Moore, the son of Mrs. Bloomfield Moore, who aided Keely financially in his experimental work, was a spectator, and Mr. Coleman Sellers, Jr., took part in the examination of the flooring. The work of these investigators consisted of tearing out the flooring and ceiling and closely examining the walls and partitions for indications of the use of any means of conveying electrical or other power from one part of the building to another. The hollow steel sphere which was found under the flooring some time ago was found to rest on the original clay bottom of the building, and that to put it in place sections had been sawed out of two of the floor beams. It was calculated that the sphere weighed three tons and was capable of withstanding an internal pressure of 25,000 to 100,000 pounds per square inch. At the top of the sphere was a hole with threads for a screw connection. There was also found a piece of heavy iron pipe which was evidently made to withstand a high pressure. An examination of the second floor of the building revealed a false ceiling of wood with a space of about two inches between the boards and the timbers, where wires or tubes might have been concealed. No tubes or wires, however, were found. Under the floor were found a strong-walled brass tube running through holes bored in the floor beams and a similar piece of tube was found built into the partition wall. There was also found among the rubbish on the premises a small coupling intended to join such tubes and the ends of the tubes themselves were fitted for couplings. It is stated that the investigators agreed that the steel sphere was probably used as a storage reservoir for compressed air or gas which was used by Keely to produce the effects which he exhibited. They declare that the tubes found are identical in appearance and size with what Keely declared were the wires which he used to convey his "vibratory" power. No evidence was found to show that Keely used electricity in his work; indeed, it is said by some that he had no knowledge whatever of the science.

WESTERN NEW YORK NOTES.

FROM MULES TO ELECTRIC POWER.—The Town Council of Clifton, Ont., is considering the change of motive power on the tramway line to Drummondsville from mules to electricity. At a meeting held on January 16 some progress was made toward a solution of the difficulties attendant thereon.

ELECTRIC PLANT FOR THE BUFFALO PUBLIC LIBRARY.—The trustees of the Buffalo Public Library are considering the installation of a steam and electric lighting and power plant for the library building. This will include an electric passenger elevator and book lifts. Messrs. Esenwein and Johnson are architects for the trustees.

THE BUFFALO GENERAL ELECTRIC COMPANY, Buffalo, N. Y., is just beginning the construction of a house for the 3,000-hp storage battery recently ordered of the Electric Storage Battery Company. The building will be 100 feet by 30 feet and 15 feet high inside, and will be completely fireproof. It will be located in the rear of the new station on Wilkeson Street.

THE DEPEW & LANCASTER LIGHT, POWER & CONDUIT COMPANY is said to have contracted for a right-of-way for a transmission line between Depew, N. Y., and the power transmission line of the Cataract Power & Conduit Company, at Tonawanda. The Depew & Lancaster Company owns valuable franchises for the distribution of electric power in the same two towns. A bill has just been introduced into the State Legislature by Assemblyman Patton conferring powers upon the company to acquire real estate by purchase, lease, or, in case of disagreement, by right of eminent domain. Mr. John N. Scatchard is president and Mr. Raphael Herman secretary, both of Buffalo.

THE LIMA-HONEOYE FALLS ELECTRIC LIGHT & RAILROAD COMPANY has decided to remodel its railway power station. This railway operates one long heavy passenger car with four-motor equipment and one electric freight locomotive, and power has been furnished by two single-cylinder four-cycle gasoline engines belted to countershaft. This arrangement has not proved satisfactory, and will be replaced with a steam plant consisting of a pair of Babcock & Wilcox water-tube boilers of 175 hp capacity each and two simple engines of 135 I.H.P., each made by the Ball Engine Company, of Erie, Pa, and belted to the same shafting. Messrs. Carlton and Meadows, of Buffalo, are consulting engineers.

CHICAGO NOTES.

THE ANNUAL MEETING of the Chicago City Railroad Company was held on the afternoon of January 16. The capital stock was increased from $12,000,000 to $14,000,000, and the old board of directors was re-elected. The stockholders held a meeting after that of the directors, and re-elected the present officers with the exception of Mr. Joseph Leiter, who becomes first vice-president, and Mr. D. G. Hamilton, who succeeds Mr. Leiter as second vice-president. The financial report of operations for 1898, as compared with the year 1897, shows total earnings, 1898, $4,832,805; 1897, $4,816,516. Operating expenses, $2,926,490 and $2,908,982, respectively. After adding bond interest, depreciation, etc., the total expenses are $3,224,367 and $3,166,860. Net earnings, $1,608,437 and $1,649,656, less dividends (each year), $1,440,000. The decrease in the net earnings is explained by the writing off of a large amount for depreciation. The operating expenses for the year, including interest, insurance and taxes, were 60.55 per cent. of the total earnings.

THE WESTERN ELECTRIC COMPANY ENLARGING ITS PLANT.—The large manufacturing plant of the Western Electric Company, in the block bounded by Clinton, Jefferson and Congress Streets and Jefferson Place, in this city, has just been enlarged by the addition of a building 50 by 180 feet and ten stories high, and plans have been made for another eight-story building, to be 50 by 124 feet. The company is also contemplating the erection of a seven-story structure, 27 by 72 feet. All of these buildings are simply additions to the already extensive plant of the company. They will all be of steel construction, with tile and brick walls, partitions and floors, and thus rendered fireproof. The boiler house will also be enlarged. A second battery of boilers each of 400 horse-power will be installed over those already in use on the ground level, without interfering with the operation of the old boilers. Above the second level of boilers will be built a coal bin of 1,000 tons capacity. Coal will be conveyed by power from the street to the top of the bin, thence it will be delivered automatically to the boiler furnaces below. The total capacity of the boilers will be 3,300 horse-power. A steel stack 203 feet high and 12 feet internal diameter has just been erected. It is one of the tallest chimneys in Chicago.

INDIANA NOTES.

TELEPHONE FRANCHISE IN NOBLESVILLE.—The Council of Noblesville has granted the new telephone company a franchise to operate a telephone system in that city.

FRANCHISE REFUSED.—The Elkhart Council on January 14 refused to grant a perpetual franchise to the Indiana Electric Railway Company for the

use of the principal streets in order to operate a line from Elkhart to South Bend.

ARTICLES OF INCORPORATION were filed on January 16 by the Northeastern Indiana Street Railway Company with a capital stock of $80,000. The railway will operate in the northern counties and connect a number of important cities.

MUNICIPAL LIGHTING IN EVANSVILLE.—The City Council of Evansville on January 17 unanimously passed an ordinance calling for municipal ownership of an electric light plant to cost $75,000. This is a new departure for the city.

THE NEWCASTLE ELECTRIC STREET RAILWAY COMPANY, composed of local capitalists, has secured right-of-way to Cadiz, Knightstown, Spiceland and Ogden. Cincinnati capitalists will assist in extending the line to Cincinnati, and will locate factories in the gas territory along the line.

PHILADELPHIANS AFTER THE TERRE HAUTE STREET RAILWAY.—There is a well authenticated report that the Philadelphia capitalists who own the gas company stock of Terre Haute have formed a syndicate to purchase Russell Harrison's street railway and electric light plant when sold by the court.

AN ELECTRIC RAILWAY LINE will be constructed from Richmond to Hamilton, O. A mass meeting at Fairhaven, O., resulted in immediate steps being taken to secure right-of-way and franchises. The line will be known as the Richmond & Hamilton Electric Railway. The intervening points will be Boston, Beechymire, Fairhaven, Darrtown and Morning Sun. Foreign capitalists are ready to invest in the project.

GRANTED A 50-YEAR FRANCHISE.—The commissioners of Marion county on January 18 granted a 50-year franchise to the Indianapolis & Logansport Traction Company, and right-of-way over the Michigan road through said county, from Indianapolis to the northern border. The company agrees to begin work on or before September 1, 1899, and complete the grade within one year, and to have the road in full operation by September 1, 1900. The passenger rates are to be five cents for the first mile and one cent a mile thereafter, and the charges for freightage are to be not over 50 per cent. of the charges of steam railway companies.

A WHOLESOME LESSON IN MUNICIPAL LIGHTING.—The city of Crawfordsville put in a $100,000 electric light plant at the city's expense, operating the plant in opposition to a private plant, which was forced to quit business. The municipal plant was built in an extravagant manner and undertook to give the citizens something for nothing and established ruinous low rates. The price of service was subsequently raised, but the revenue derived from municipal lighting failed to pay for the cost of the street lighting, as the champions of the municipal ownership of a light plant had argued. The city is now compelled to increase the capacity of the plant or sell out and a committee has been appointed to investigate which horn of the dilemma it is advisable for the city to take. It is not unlikely that the plant will be offered for sale, and the citizens are averse to spending any more money on the white elephant.

THE INDIANA TELEPHONE ASSOCIATION, composed of independent companies throughout the State, held its annual meeting at Indianapolis on January 18. More than fifty companies were represented. The general report was to the effect that these companies are growing in strength, and that they are widening the use of the telephone to a remarkable degree by giving cheap and efficient service. Two of the independent exchanges, one at Noblesville and the other at Newcastle, have been bought in by the Central Union Company, but members of the association say they do not expect any other desertions from their ranks. The members express confidence in the movement to establish an independent telephone system in Indianapolis which will in time be connected with all the independent exchanges in the State. The following officers were elected: President, E. H. Andress, Lafayette; vice-president, A. A. Reynolds, Crawfordsville; secretary and treasurer, H. B. Gates, Indianapolis. An executive was named. No new legislation is desired, but the General Assembly is being carefully watched to prevent, if possible, any adverse legislation.

St. Louis Notes.

FOR CHEAPER CAR FARES.—A bill was introduced in the Legislature last week providing that street car lines in St. Louis shall charge only half fare between the hours of 5:30 and 7:30 o'clock in the morning and evening.

TO CONSOLIDATE ST. LOUIS STREET RAILWAYS.—New York financiers are credited with having secured options, the effect of which will be the merging of all street railways of St. Louis, except the Suburban line, into one syndicate.

TO PAY FOR COUNTY FRANCHISES.—A bill requiring street railway companies to pay for franchises in counties has been introduced in the Legislature. It also provides that it shall be compulsory for the county court to make the granting of franchises to street railways conditional upon the construction and maintenance by the company of a roadway on either side of the track or tracks.

THE COLUMBIA INCANDESCENT LAMP COMPANY, of St. Louis, Mo., held its annual election recently and selected the following named gentlemen: Mr. W. O. Garrison, president; A. C. Garrison, vice-president and treasurer; George P. Rex, acting secretary. Vice-President A. C. Garrison will continue to have charge of the general management of the company's business affairs, and Mr. George P. Rex, who has been representing the company in Chicago, will assist in the routine work of the office. Mr. W. O. Garrison, formerly vice-president, will act in an advisory capacity.

TO ABOLISH A STREET RAILWAY LAW.—The bill to abolish the street railway law known as the "Third Parallel," introduced in the Legislature by one of the members, is one of great moment to the Central Traction Company. The law was enacted several years ago and prohibits the construction of a second or third track parallel to and within three squares of either side of any other railroad. The law has never been tested, but the Southern electric line was about ten years ago enjoined for two years from construction. The Suburban experienced a similar predicament until the Legislature decided that rights already acquired by railroad companies would not be interfered with.

Pacific Coast Notes.

NEW INCORPORATION.—The Woodill & Hulse Electric Company has been incorporated for the purpose of doing electrical contracting. Directors: H. B. Woodill, B. F. Hulse, Clara T. Hulse, F. J. Woodill, J. M. Rafferty and L. D. Gray, all of Los Angeles. Capital stock, $10,000, all subscribed.

THE ST. HELENA ELECTRIC LIGHT & POWER COMPANY was recently incorporated for the purpose of building and operating electric light plants. Principal place of business, San Francisco. The directors are J. E. Primstone, George W. Crum, L. St. D. Roylance and W. A. Leonard, San Francisco. Capital stock, $30,000; subscribed, $50.

THE MUTUAL ELECTRIC COMPANY, San Francisco, has filed a notice of its intention to commence laying wooden underground conduits for electric cables from McAllister Street through Larkin, Market and Valencia Streets to Fourteenth. This company has just published a largely signed petition to the board of supervisors. It asks that it be allowed the privilege of erecting poles for electric wires outside the fire limits for the purpose of supplying light to the city.

THE FAMOUS LEGAL CONTROVERSY between the city of Tacoma, Wash., and the estate of Charles B. Wright and the legal representatives of the Tacoma Light & Water Company has been compromised. The original litigation arose from the claim—made some time after the purchase of the above company's electric lighting plant by the city—that the price paid was far in excess of its value. By the terms agreed upon the city will receive $100,000 in cash and in addition the electric light plant, franchises, etc., formerly controlled by the defendants. It is provided that the city authorities make such assurances against competitive cutting of lighting rates as they lawfully can. With the plant under the absolute control of the city it gives the municipality the practical control of the entire light and power business of Tacoma. The city has driven out competition.

Canadian Notes.

THE ROYAL TELEGRAPH COMPANY.—It is currently reported that four prominent barristers of Ottawa will seek incorporation at the next session of the Dominion Parliament as the Royal Telegraph Company, with a capital of $1,000,000. It is proposed to construct and operate telegraph and telephone lines throughout the Dominion.

ELECTRIC RAILWAY EXTENSION.—A report is current that the electric street railway at Sherbrooke, Que., has been purchased by Frank Thompson & Co., financial agents, of that city. This company is said to have secured the Brompton Falls water power, and to have decided to proceed at once to extend the line of railway to North Hatly and other points.

EARNINGS OF THE TORONTO STREET RAILWAY.—The annual meeting of the Toronto Electric Street Railway was held last week. The statement for the past year shows the net earnings to have been $360,000. After paying a four per cent. dividend the company carries forward to the rest account the sum of $100,000, and thus swelling this account to nearly $1,000,000.

AUTOMOBILES IN OTTAWA.—An Ottawa capitalist who has been negotiating for the purchase of automobile carriages for service in the capital of the Dominion has been notified that a Toronto agency for the manufacture of the carriages has been opened there. The agency is a branch of a leading American firm, and carriages of all kinds will be built this year. The carriages which will be brought to Ottawa will be simple in construction and suitable for use on any street.

A LARGE POWER PLANT.—The plant of the newly incorporated Metropolitan Electric Company, of Ottawa, will cost in the neighborhood of $300,000. It will have a capacity of 5,000 horse-power but only 2,000 horse-power of this will be utilized at present. The power will be brought in from Britannia, about eight miles from the city, to a transforming station at a pressure of 10,000 volts, where it will be transformed to 2,000 volts for distribution in the city. The power cost the company a short time ago $20,000, but the company has since been offered $80,000 for it.

TO ESTABLISH A CALCIUM CARBIDE PLANT.—It is understood that a company is being organized with a capital of about $1,000,000 by gentlemen in Montreal, Boston and Paris, France, for the purpose of manufacturing calcium carbide on a large scale. The company will operate at the Shawinigan Falls, on the St. Maurice River, Que., utilizing part of the power being developed at that point by the Shawinigan Water & Power Company. The company claims that it will operate under such great advantages at this location that it will be able to sell calcium carbide at greatly reduced prices.

LETTER CARRIERS ON STREET CARS.—There is an arrangement between the Dominion Government and the electric railway companies operating in most of the large cities of Canada by which letter carriers use the street cars in the performance of their duties. For this consideration the Montreal Street Railway Company has been paid $200 per month, but the Postmaster General was notified some time ago that the service would be discontinued on that basis. The railway company claims that a record of the work performed shows that at regular fares the sum to be charged would amount to over $1,000 per month, and hence their refusal to renew the contract on the former terms. In Toronto the price paid is said to be $400 per month.

French Notes.

THE GHENT SOUTHERN STATION.—The electrical equipment of the Ghent Southern Station will consist of two 120-kw generators driven by two 175-hp engines, and running at 400 r. p. m. For lighting the street between the depot and the arsenal forty-two arc lamps will be suspended from iron masts 53 feet high. The storage sheds and car sheds will have fourteen arc

lights; the train shed will have twenty-one; the offices and waiting-rooms will have fourteen. These arcs will consume 14 amperes each. There will be, in addition, 300 incandescent lamps scattered about in various places. The circuits will absorb some 16 tons of copper. The cost of the entire work is estimated at $35,000.

ELECTRICITY IN GHENT.—The cars of the electric railway system of Ghent are all to be driven with the new form of the Julien accumulator. Each element has 120 positive plates of pure lead 5 13-16 inches by 7 11-16 inches by 1-32 inch thick. These plates are made with ribs, and are piled one on top of the other, making a solid cube about 10¼ inches high; the ribs being staggered, the acid has ready access to every plate. This positive block is pierced vertically by twenty holes, in which are fitted cylinders of compressed chloride of lead; these cylinders form the negative electrodes, and they are insulated from the positive material by a jacket of perforated hard rubber. The element is contained in a hard-rubber box 6 11-16 inches by 8 1-32 inches by 13 inches high. This box has no cover, but to prevent the fine spray, due to gasing, from leaving the box, a layer of oil is poured over the acid. The complete cell has 120 positive plates, weighing 23.1 pounds; 20 chloride cylinders, weighing 18.7 pounds, and 14.3 pounds of acid. The complete weight is about 64 pounds. The car carries 108 cells, in twelve wooden cases, containing nine cells each, the whole being under the seats. The weight of one of these cases is about 600 pounds, making the weight of the battery 7200 pounds.

PARIS ACADEMY OF SCIENCES.—At the meeting on November 28, 1898, M. Mascart read a paper by E. Lacoine on "A Method for Preventing Ship Collisions During a Fog." It is suggested that to guide vessels when entering a harbor there should be erected on each side of the passage stations called phonophoric stations, connected together with an electric circuit and furnished with apparatus for producing, simultaneously at regular intervals, intense sounds of different pitch. The time elapsing between the hearing of the two sounds on the vessel is a measure of the difference in distance from the ship to the two stations, so that the ship is situated on a fixed hyperbola, whose foci are at the two stations. If one of the stations were to emit simultaneously two sounds, one in the air and the other in the water, and if the vessel were provided with proper apparatus for recording the two sounds, the actual distance could be deduced from the length of the time-space between the reception of the two signals, resulting from the differing rates of propagation in the two media. It is possible to determine the distance between two vessels, either by a double propagation apparatus in water and air, or by a single sound emitted from one vessel and answered by the second; if the answer is given instantly on the reception of the first signal, the distance is known at once on board the first ship by the length of time elapsing between the emission of the first signal and the reception of the answer. The ships would then make some preconcerted signal to indicate that they were ready for phonophoric communication.

AN ELECTRIC LOCOMOTIVE ON THE PARIS-LYONS-MEDITERRANEAN RAILWAY.—This company has been experimenting since the end of 1897 on the line between Paris and Milan with a high-speed electric locomotive, designed by M. Baudy, chief engineer of the motive power and rolling stock department. This engine has about one-half the power of the ordinary express locomotive, but the power is applied on two axles, so that the engine can be brought up to the nominal power by adding another pair of axles. The power is obtained from a storage battery carried in a specially built tender and dragged by the locomotive. A large part of the pull exerted by the locomotive is expended in dragging the battery car, which would, of course, be replaced by useful load if the power were taken from a conductor laid along the track. The object of this arrangement is to study the high-speed electric locomotive without being obliged to equip the line with a conductor, and build a power station. There is a slight difference in the problem introduced by the accumulators from the necessity of keeping the current consumption below a given maximum, so as not to injure the cells. This is not the only contribution made by this company to the advancement of electric traction. There are two other cases where electricity is being used. One is a branch line at Montmartre à la Berandière, near Saint Etienne, where, owing to some timbering done in a tunnel, it becomes difficult to run steam engines. The second place is on the new line from Fayet-Saint-Gervais to Chamounix, and on the Swiss frontier, where the use of electricity was particularly advantageous, because of the unusually heavy grades, combined with the presence of the waterfalls of the Arve, which made electrical energy very cheap to produce.

General News.

NEW INCORPORATIONS.

THE SHERMAN ELECTRIC LIGHT COMPANY, Sherman, N. Y., has been formed with a capital stock of $5,000. Those interested are F. L. Cornish, C. E. Cobb, A. J. Arnold, J. G. Bly and W. A. Edmunds.

THE CLEVELAND & WARREN STREET RAILWAY COMPANY has been organized at Warren, Ohio, by Martin Dodge, C. A. Thorpe, J. B. Corlett, E. B. Lockwood and J. E. Phillips.

THE NEWPORT ELECTRIC LIGHT & POWER COMPANY, Newport, R. I., has been incorporated with a capital stock of $15,000. The directors are William D. Grant, D. K. Brown and Henry H. Dexter, Newport.

THE CITIZENS' TELEPHONE COMPANY, Woodstock, Ill., has been incorporated with a capital stock of $20,000. The officers are: President and manager, Marcellus Joslyn; secretary, A. B. Wager; treasurer, D. R. Joslyn.

THE MULTIPLEX INCANDESCENT LAMP COMPANY, Jersey City, N. J., has been formed with a capital stock of $250,000. The incorporators are Ferdinand von Kusserow, Grant Green, New York; Frederick C. Russell, Newark, N. J.

THE COUNCIL BLUFFS GAS & ELECTRIC COMPANY has been incorporated with its principal office in Jersey City, N. J. The incorporators are F. Gilmore, H. J. Smith, H. Wykes, V. Cumberson, T. J. Kennedy, W. B. Hood and A. E. Walradt. Capital stock, $250,000.

THE HASBROUCK MOTOR COMPANY, New York, N. Y., has been incorporated at Charleston, West Va., with a capital stock of $3,300. The incorporators are W. H. Hassett, Belleville, N. J.; L. F. Dickerson, Newark, N. J.; W. H. Birchall, C. F. Herwan, J. Hasbrouck and S. A. Hasbrouck.

THE AMERICAN & WEST INDIA CABLE COMPANY, Jersey City, N. J., has been incorporated with a capital stock of $100,000 for the purpose of constructing and operating submarine cables, etc. Among those interested in the new company are George F. Vickers, Edward M. Hunt and Augustus C. Kellogg.

THE UNITED ELECTRIC COMPANY has been incorporated at Charleston, West Va., the principal office being at New York. The incorporators are W. E. Sheffield, Brooklyn; P. K. Green, Jersey City; W. S. McClymont, Bensonhurst; A. G. Haven, Fairview, N. J., and H. H. Lamberson, New York. Capital stock, $1,000.

THE INTERNATIONAL TRACTION COMPANY, Jersey City, N. J., has been incorporated for the purpose of supplying power to railroads, to construct and equip railroads, etc. Among the incorporators are Charles McVeagh, Lasalle J. Hayden, William H. Blain and Benjamin W. Franklin. Capital stock, $85,000.

THE EAST SIDE TRACTION COMPANY, of Syracuse, N. Y., has been formed with a capital stock of $400,000 for the purpose of operating an electric road in the city of Syracuse. The directors are William G. Tracy, George D. Chapman, C. M. Warner, F. M. Bonta, G. R. Leonard, M. C. Pierce, John T. Nash, Frank J. Webb and Clinton S. Carr.

THE ASTORIA LIGHT, HEAT & POWER COMPANY has been incorporated at Albany, N. Y., with its principal office in Queens Borough, for the purpose of supplying gas and electricity in the city of New York. The directors are Horace M. Fuller, Augustus R. Moen, Arthur C. Hume and Francis K. Foraker, of New York City, and T. Wilbur Spear, of Brooklyn. The capital stock is $500,000.

THE TRENTON & PRINCETON TRACTION COMPANY has been incorporated at Trenton, N. J., with a capital stock of $200,000, to build an electric railway between Trenton and Princeton, nine miles distant. The incorporators are Ex-Senator George O. Vanderbilt, of Princeton; Charles W. Shippee, of Boston, and Julius Garat, Elmer E. Carpenter and Henry Lincoln, all of Worcester, Mass.

THE INDIANAPOLIS & LOGANSPORT TRACTION COMPANY filed articles of incorporation with the Secretary of State, with a capital stock of $100,000. The purpose of the company is to construct an electric railway connecting the cities of Indianapolis, Logansport, Frankfort and Warsaw. The incorporators are George J. Marott, Horace F. Wood, R. C. Light, Alfred R. Hovey, Michael A. Jordan and John Ruckelhas.

THE NEW ENGLAND ELECTRIC POWER COMPANY, Portland, Me., has been incorporated with a capital stock of $500,000. The incorporators are P. S. Saltonstall, Milton, Mass.; E. P. Shaw, D. K. Snow, Brookline, Mass.; S. R. Anthony, N. Anthony, A. Potter, F. Y. Hall, Boston, Mass.; W. G. Beancroft, Auburndale, Mass.; E. P. Kidson, Neponsett, Mass.; R. M. Saltonstall, Newton, Mass.; H. E. Boothby, Reading, Mass.; J. Drummond and J. Drummond, Jr., Portland.

THE GENERAL ELECTRIC COMPANY, of Minneapolis, Minn., has been organized at Trenton, N. J., with a paid-up capital stock of $2,100,000. The certificate of incorporation states that the business of the company will be carried on in and near Minneapolis, although the company is empowered to do business in any part of the world. The charter covers every method of producing and distributing light, heat and power by electricity, and the company may build and use subways, obtain municipal permits and hold the stock and securities of other companies. Little has been learned as yet regarding the promoters of the new enterprise and its aim. It is asserted in some quarters, however, that its incorporation is a step in the direction of a gigantic consolidation of electric light and electric street railway companies throughout the country. It is thought that it is backed by the same capitalists who have recently been prominent in companies recently incorporated in Trenton and in Philadelphia for the purpose of consolidating electrical interests.

THE TELEGRAPH AND TELEPHONE.

NASHVILLE, TENN.—There is a movement on foot here looking to the introduction in the Legislature of a bill to bring about a reduction in telephone rates. A committee consisting of legislators and citizens has been appointed to draw up a bill and fix rates.

PARKERSBURG, W. VA.—The Mercer Telephone & Telegraph Company has been organized, the following named officers being elected:—President, L. R. Heath; vice-president, George A. Smith; secretary, J. J. Alexander; treasurer, John I. Gordon. The company expects soon to have a toll line in operation between New Castle and Youngstown.

SHREVEPORT, LA.—The Citizens' Co-operative Telephone & Telegraph Company and the Cumberland Telephone & Telegraph Company are to be amalgamated, the combined system to be under the management of the Cumberland company. The Cumberland company, it is stated, will pay $20,000 for the Citizens' franchise and all its rights and privileges. The rates for telephone service will be, for residences $18 per annum, and for business houses $42 per annum. This service will cover the territory embraced within a radius of from 40 to 60 miles from Shreveport.

BOSTON, MASS.—A bill has been introduced in the State Legislature providing that all matters pertaining to rates and service of Massachusetts telephone companies shall be under the supervision of the Board of Gas and Electric Light Commissioners. The board will also have power to recommend changes in rates and service and inspect books and records of companies. Jurisdiction is given the board to embrace the rates charged by one telephone company to another telephone company. Upon a complaint of the mayor of any city in the Commonwealth, or the Selectmen of any town, or by twenty subscribers, in respect to rates or service the board will give a public hearing in the matter.

CHICAGO, ILL.—The board of directors of the Michigan Telephone Company on January 18 elected as officers of that company the managers of the Erie Telegraph & Telephone Company. Mr. Ashley Pond, of Detroit, re-

signed as director of the company and Mr. Charles J. Glidden was elected to fill the vacancy. The board as reorganized is as follows: President, Charles J. Glidden, Lowell, Mass.; vice-president, James P. McKinstry, Cleveland, Ohio; secretary, George B. Perham, Lowell, Mass.; treasurer, Charles A. Grant, Lowell, Mass.; general manager, Frederick A. Forbes, Detroit, Mich.; local treasurer, Hugh McMillan, Detroit, Mich. The following named directors of the Michigan Telephone Company will remain in office: Robert T. Lincoln, Colonel R. C. Clowry, W. A. Jackson, president of the Central Union Telephone Company; Norman Williams, Chicago; Frederick A. Forbes and Hugh McMillan, Detroit.

Electric Light and Power.

JOPLIN, MO.—A committee of representative men in this city, appointed by the Council, have decided to report to that body in favor of establishing a city electric light plant to cost from $30,000 to $35,000.

CHARLESTON, S. C.—It is announced that the Charleston City Railway Company, the Sea Shore Railway Company, the gas company and the electric light company of this city will be consolidated under one management, to be in control of Baltimore capitalists.

OSHKOSH, WIS.—The Oshkosh Electric Light & Power Company has installed apparatus in its station for the purpose of supplying electric power in the daytime. A number of manufacturers and business men have arranged to take the power, which will be furnished at a low meter rate. A Western Electric generator will supply the power for the day circuit.

MOBILE, ALA.—The rebuilding of the station of the electric lighting company of Mobile has been completed, the work having been carried on without interfering with the regular service. The new apparatus includes an Allis-Corliss tandem-compound condensing engine of 500 horse-power, which drives six large dynamos, one of 125 arc-light capacity, two of 4,000 incandescents each, one of 1,500 incandescents and two of 25 arc lights. The switchboard is 25 by 15 feet in size. There is a battery of six boilers, including two new Sterling water-tube boilers, the aggregate capacity being 1,000 horse-power.

GRAND RAPIDS, MICH.—The Board of Public Works will report to the City Council a plan for a system of underground conduits, the same to be owned by the city and rented to telegraph, telephone, electric lighting and other companies. Only the business district is involved in the work. The report will recommend that the conduits be put in on the separate system, that is, one conduit or set of conduits to carry all wires for light, heat and power purposes, and another set for all telephone, telegraph and fire alarm wires. It is also recommended that outside the conduit district all light, heat and power wires be strung on one set of poles on one side of the street, and all wires for other purposes on another set of poles on the other side of the street. The report will be considered at the next meeting of the Council.

The Electric Railway.

HUDSON, N. Y.—The Hudson Transit Company has purchased the Kinderhook Electric Light Company, which lights the city of Rensselaer. Work on the new power house at Rensselaer will be commenced at once.

PHOENIXVILLE, PA.—The Montgomery & Chester County Electric Railway Company has been granted a franchise to build and operate a street railway in this borough. Each car will be taxed $15 per year.

LEBANON, PA.—The Lebanon & Annville Street Railway Company and the Lebanon & Myerstown Street Railway Company have each declared a semi-annual dividend of 2 per cent. At the annual meeting of the two concerns, Mr. S. P. Light was elected president of each.

ALLENTOWN, PA.—The Easton and Nazareth Street Railway Company has been incorporated. The length of the road will be about 10 miles. Capital stock, $60,000. The officers and directors are: William O. Hay, Easton, president; Edward J. Fox, Easton; Charles H. Cox, Bethlehem; Robert A. Stofflet, Easton; Thomas A. H. Hay, Easton.

McKEESPORT, PA.—It is stated that the Monongahela Electric Company has passed into the hands of a syndicate of Braddock and Pittsburg capitalists, the consideration being about $100,000. The purchase includes the franchises of the company for lighting Belle Vernon, Charleroi and Monongahela. It also includes the right of way of the electric railroad now operated between Belle Vernon and Charleroi.

CHAGRIN FALLS, OHIO.—Another electric street railway is proposed from this place to Warren, thus completing an electric line from Cleveland, Ohio, to Pittsburg, Pa. Prominent citizens of Geauga, Portage and Cuyahoga counties have interested Eastern and Cleveland capitalists. The route of the proposed line will be south from this place to Bainbridge, thence to Auburn, Troy, Rapids and Hiram, direct to Warren.

BALTIMORE, MD.—It is stated that the Electric Company of America, which was recently incorporated at Trenton, N. J., with a capital stock of $25,000,000, has opened negotiations for the purchase of the Northern Electric Company, of Baltimore. The new company is reported to have offered $140 per share for the Northern stock. No one connected with the Northern Company could be induced to make any statement regarding the proposition, but there is every reason to believe that negotiations have actually been initiated. It is generally believed that the electric company is also preparing to make an offer for the stock of the Edison and Brush companies in this city.

TACOMA, WASH.—A special from Everett says J. D. Rockefeller's representatives are planning the erection of a mammoth electric plant to operate a railroad and factories there. Among these are the Everett and Monte Cristo Railway, 65 miles long; mining machinery and concentrator at the Monte Cristo mines, a paper mill, nail works, a smelter and a city lighting plant. Power for these is now produced by steam at great expense. It is found that by using electric power the resulting economies will pay for the electric plant in three years. Engineers have made surveys along Stillaguamish River, finding a good dam site at Granite Falls. This dam will furnish water power a generation for all the electric power required. It is believed that the Westinghouse system will be used.

Legal Notes.

THE BEACON LAMP COMPANY.—On January 23 a petition in involuntary bankruptcy was filed against the Beacon Lamp Company, of New Brunswick, N. J., by the attorneys of Mr. Charles Shoninger, a creditor.

THE CO-EMPLOYERS' ACT.—The Indiana Supreme Court has held the Co-employees' Act to be constitutional. This act applies to railway corporations alone, and the claim was made that the law unjustly discriminated against corporations operating steam and electric railways. An appeal has been taken to the Supreme Court of the United States.

MENTAL ANGUISH CAUSED BY NEGLIGENT DELIVERY OF A TELEGRAM.—The non-arrival of a brother-in-law, in consequence of a negligent delivery of a telegram announcing a death, is not presumed to entail such mental anguish as to make the company liable. It would be different in case of a husband, wife or near blood kindred, says the North Carolina Supreme Court in Cashion vs. Western Union Telegraph Company.

TELEPHONE COMPANY BLAMELESS.—When a telephone company, by permission, is laying wires underground and necessarily occupying a part of the street, it cannot be held liable in damages for the death of an experienced driver who chose to go over the narrow space and was thrown from his wagon and killed, there being another way open to him. Cain vs. Ohio Valley Telephone Company, Keentucky Supreme Court, December 5, 1898.

AN ALLEGED INFRINGEMENT OF THE MAGNETIC BLOW-OUT PATENT.—The General Electric Company has brought suit against the Bullock Electric Manufacturing Company to restrain it from manufacturing certain devices which utilize the magnetic blow-out which, it is claimed, infringes the patents No. 283,167 and 401,085, granted to Elihu Thomson. The suit came up before Judge Lacombe in the United States Circuit Court on January 20.

INJURIES BY LIGHTNING ON TELEPHONE LINES.—A $5,000 damage suit brought by Kate Jennings versus Johnson is being tried in the Johnson County (Ind.) Circuit Court, on change of venue from Bartholomew Circuit Court, where the cause was tried, resulting in a failure of the jury to agree. Johnson is the owner of the Greenwood telephone exchange, and Kate Jennings, the plaintiff, was talking over the 'phone in June last, when a bolt of lightning struck the telephone wire and, owing to a lack of "grounders," the lightning tore out the transmitter and seriously injured Miss Jennings. Much interest is manifest in the case, and it will require a week to try it. Expert testimony is in demand, and the principle of negligence involved is of radical interest to telephone companies.

THE ARMINGTON & SIMS COMPANY.—The Rhode Island Supreme Court has decided in favor of the complainants, Messrs. Pardon Armington and Gardiner C. Sims, upon the question of the right of the Armington & Sims Company to use the names "Armington and Sims" against the wishes of Mr. Armington and Mr. Sims. When the business of the Armington & Sims Engine Company was reorganized, after the failure in 1896, the new company adopted the title of the Armington & Sims Company, notwithstanding the written protest of Mr. Sims, and Sims' claim that this is a wrongful and injurious use of their names, and an injunction was asked for. In deciding the case, which was brought against Mr. Julius Palmer and other organizers of the new company, the court states that the name adopted by the new company is so like that of the Armington & Sims Engine Company that it would be misleading and confusing in business matters, as the old company is still in existence; that the respondents did not acquire the right to use the name by purchase, and bought only the plant, machinery, stock and such visible property.

Personal Notes.

MR. D. A. ANDREWS, JR., has resigned his position as treasurer of the Pettingill-Andrews Company, of Boston. Mr. Charles B. Price, general manager of the company, will hereafter act also as treasurer.

MR. E. A. LOWE has tendered his resignation as manager of the firm of J. Jones & Son, New York. The resignation will take effect on February 18. It is Mr. Lowe's intention to establish himself in the same line of business in this city.

RESIGNATION OF MR. FRANSIOLI.—Mr. William J. Fransioli, general manager of the Manhattan Elevated Railway Company, of this city, has resigned his position and has become associated with the New York Auto-Truck Company, which was recently organized by Mr. Richard Croker and others to operate air-driven trucks in the streets of New York. Mr. Fransioli is enthusiastic over the prospects of this new application of compressed air.

MR. L. H. ROGERS, of the Fort Wayne Lamp Company, Fort Wayne, Ind., resigned his position early in January for the purpose of giving his entire time to the business of the Oklahoma Cement & Plaster Company, Cleveland, Ohio, of which concern he is treasurer. While Mr. Rogers was connected with the Brush Electric Company his attention was brought to some very valuable cement deposits in Oklahoma Territory. They have been developed to such an extent that he has found it necessary to give his entire time to the business of marketing the product of the mills, which have been running for some six or eight months.

MR. ELIAS E. RIES, consulting engineer and electrical expert, has moved his office from the Temple Court building to the New York Life building, 346 Broadway, New York. Mr. Ries is associated with several other gentlemen in the newly organized United States Automatic Telephone Company, whose office is also in the New York Life building. The company has secured control for the United States of the basic patents granted to Mr. Ries upon his automatic telephone system, which was briefly described in The Electrical World of December 17, 1898. Mr. Ries has had an extended practical experience as an inventor, and there is scarcely a line of electrical developmnt in which he has not done original work.

Trade and Industrial Notes.

MR. W. R. MASON, 314 Security Building, St. Louis, Mo., has been appointed selling agent for the Siemens & Halske Electric Company of America, with headquarters in St. Louis.

MESSRS. A. C. POWELL & SON, of Syracuse, N. Y., have received an order for a 100-light direct-connected dynamo, to be used in lighting the Syracuse Reduction Company's works.

HOW TO CARE FOR "PETITE" ARC LAMPS.—The Western Electric Company has issued a small pamphlet, giving directions for trimming and taking general care of the "Petite" enclosed arc lamps which are manufactured by that concern.

THE ELECTRIC APPLIANCE COMPANY, Chicago, claims that its No. 11 telephone is a little better than anything else on the market. This is a bold claim to make, but the company is backing it up with a very liberal offer which telephone companies would do well to investigate.

THE WIRE COMBINATION.—It is stated that control of practically all the steel and wire plants in the United States has been obtained by the American Steel & Wire Company. There are two or three mills which have not yet been purchased, but cash has been reserved to buy them.

THE SIEMENS & HALSKE ELECTRIC COMPANY, Chicago, Ill., has received an order from the Northwestern Elevated Railroad Company, Chicago, to build three 1,500-kw and one 750-kw generators of the new type internal-armature. These machines are to be installed in the railroad company's power plant.

MR. JOHN E. FULLER has succeeded to the business of the North American Electric Company, 181 William Street, New York. Mr. Fuller is a manufacturing electrician and manufactures and deals in telephones, fan motors, electric bells, and will besides engage in general contracting. His address is 93-95 Maiden Lane.

"THE ELECTRICAL ERA" is the name of a new monthly paper, published in St. Louis, Mo. Mr. A. R. Rivet is the editor. "The Electrical Era" is gotten up in magazine form, and its publisher claims that it is the cheapest electrical paper published in the world. The subscription price for one year is 25 cents and the price per copy is 3 cents.

THE MORGAN ENGINEERING COMPANY, Alliance, Ohio, announces that it has found it expedient, and to the advantage of its customers, to sell its product direct and not through agencies. It has, therefore, terminated the agreement existing between itself and the Niles Tool Works Company. It requests that until further notice all communications be directed to the home office at Alliance, Ohio.

EXPORT ORDERS FOR EMERSON FANS.—The Emerson Electric Manufacturing Company, of St. Louis, a few days ago received an order from China for forty-eight fan motors and twenty-four ceiling fans, and on the next day an order for thirty alternating-current ceiling fans for shipment to Argentine, S. A. In addition to these orders the demand is said to be unusually active from the larger cities in the United States.

THE SHAWMUT FUSE WIRE COMPANY, of Boston, has issued a catalogue of tested fuse wire, tested fuse links, enclosed fuses, tablet boards, copper knife switches and switchboards. Illustrations of these various devices are given throughout the pages of the catalogue, together with price lists of the same. To insure the proper testing of fuses the company has a fully equipped laboratory for this special purpose and has now completed more than 3,000 tests.

FOCUSING ARC LAMPS.—Messrs. Baker & Fox, 83 Schermerhorn street, Brooklyn Borough, state that there is a continually increasing demand for their automatic lamps for direct and alternating current. These lamps are simple in construction and reliable and satisfactory in operation, and find their principal field in college, theatre and lecture work. They are easily manipulated and well made. These lamps were described in THE ELECTRICAL WORLD of October 8, 1898.

SIMPLEX FRICTION TAPE.—The Western Electric Company, of Chicago and New York, is furnishing its customers Simplex friction tape, packed in tin boxes. The boxes are 4¼ inches in diameter and 1 inch deep, and contain one-half pound rolls of tape carefully wrapped in oil paper. The tape is prepared with the greatest care, of high grade materials, and either white or black tape is furnished. The tape is thoroughly protected from the drying-out effect due to the exposure to air, and is also protected from dirt.

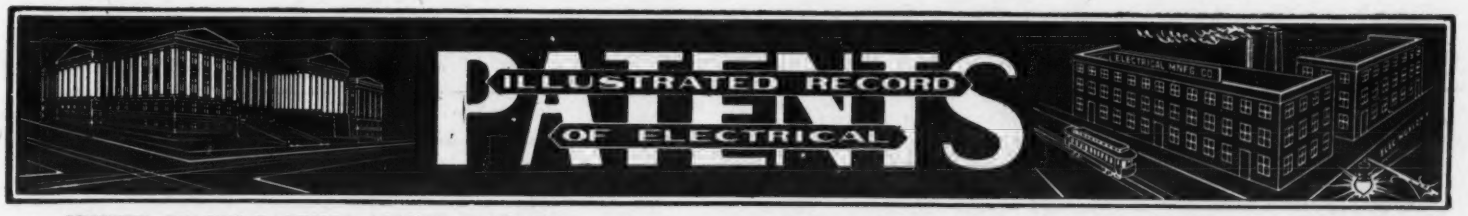
PROPOSED EXHIBITION IN GLASGOW IN 1901.—Three ex-members of the corporation of the city of Glasgow, Scotland, have arrived in this country to interest Americans in the Glasgow Exhibition of 1901. The exhibition is backed by the city of Glasgow, and the chief reason for holding it in the year after the Paris Exposition is the hope of getting a part of the American exhibits after the close of the Paris exposition. It is stated that the city of Glasgow is willing to pay the expense of transporting and storing the American exhibits. The exhibition will be held in Kelvin Grove, where there is a fine art gallery and museum, recently completed at a cost of $1,000,000.

COLUMBIA LAMPS.—The Columbia Incandescent Lamp Company, St. Louis, Mo., has just issued a very attractive catalogue of its incandescent electric lamps for all systems. The various types of lamps manufactured by this company are artistically illustrated, in full size. Each illustration is accompanied by data relating to the particular type of lamp, such as dimensions, voltage, efficiency, etc. The various styles of lamp bases are also illustrated. In every department of the company's factory the system of inspection is very thorough, and every lamp is carefully selected for the particular requirements of the order on which it is to be applied. An illustration of the company's office and factory is given at the back of the catalogue.

THE WILLIAMS ELECTRIC COMPANY EXPANDING ITS BUSINESS.—Mr. Burt Hubbell, formerly of the Keystone Telephone Company, of Pittsburg, Pa., and later with the American Electric Telephone Company, of Chicago, has recently associated himself with the Williams Electric Company, of Cleveland. Mr. Hubbell is one of the pioneer telephone men working in opposition to the Bell Company, dating his experience from 1890, when he built the first opposition telephone exchange in the country. The ability of the Williams Electric Company to manufacture a superior grade of apparatus in the telephone line, coupled with Mr. Hubbell's knowledge of the telephone trade, makes a combination that will no doubt be eminently successful in the business. This company has hitherto confined its product to magneto bells and receivers, and its success has been so pronounced that it has recently gotten out a long-distance solid-back transmitter that is claimed to be a superior instrument. It will also sell telephones and switchboards.

THE WARD LEONARD AUTOMATIC CIRCUIT BREAKERS, it is reported, have been meeting with the recognition which is always accorded by the electrical trade to a high class apparatus having meritorious features and selling at a moderate price. Electrical engineers throughout the country have been quick to appreciate the importance of the two independent switches, separately closed, but simultaneously opened upon overload by the automatic device. The independent hammer blow used to assist the springs in opening this circuit breaker is also a feature which wins great favor. The Ward Leonard Company reports that it is busy upon important orders for circuit breakers for concerns whose electrical engineers are recognized as the leaders in the electrical engineering profession, and that its business in this line is rapidly growing. It is stated that the United States Navy has specified the Ward Leonard circuit breakers upon all of its recent work. As the standard of the United States Navy in electrical matters is the highest standard in the world, the quick adoption of this circuit breaker by the Navy is the highest possible indorsement of it.

THE VICTOR TELEPHONE MANUFACTURING COMPANY, 166-174 South Clinton Street, Chicago, has made some improvements in its switchboard apparatus, which are said to be very advantageous in practical use. The connection of the drop coils is effected by providing permanent lugs on the end of the spool which extend on either side far enough to give a secure fastening for the binding posts by means of screws. By adopting this form of connection the necessity for soldering the drop wires to the terminal posts is avoided. All connections with the leading wires from the drop sections and jacks are also made by a screw connection to the binding posts, which are attached to hard rubber. Indeed, there is not a single connection or contact on the entire switchboard that is on a wood base. The company claims that its switchboard is the only one manufactured in the United States which does not place the metallic connections on wood. This method of construction insures high insulating qualities in the board which will be greatly appreciated by practical telephone men. One of these boards was exhibited at the Milwaukee convention last week, and is illustrated on page 121 of this issue.



UNITED STATES PATENTS ISSUED JANUARY 17, 1899.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

617,708. CONDUIT ELECTRIC RAILWAY; R. W. Barkley, of New York, N. Y. App. filed June 13, 1892. The combination of a series of underground air-chambers extending along a railway, an electric conductor conductor therein near the top thereof, reverse incline leading downwardly from said conductor at the ends of said air-chambers, substantially as described.

617,714. ELECTRIC CONDENSER; C. S. Bradley, of Avon, N. Y. App. filed Dec. 16, 1897. An electric condenser composed of wires wound adjacent to one another and kept from electric contact by an open spiral of insullating material wound about one of them.

617,715. ENCLOSED ELECTRIC SWITCH; W. M. Brown, of Johnstown, Pa. App. filed Sept. 11, 1897. The combination of a closed insulating vessel and a metal casing for the same, tapered passages in the opposite walls of the vessel and casing, a post passing through said vessel and fitting in said bearings, and a switch member carried by the central portion of said post.

617,726. COUNTING MECHANISM OF ELECTRIC-SUPPLY METER-METERS; S. Evershed, of London, Eng. App. filed Dec. 21, 1897. In a motor-meter, the combination with an armature-axle of an electromagnet thereon, excited intermittently by a current derived from the armature, a balanced lever pivoted to lie in mid-stroke at right angles to the said axle, having a magnetic head surrounding the said axle, adjacent to the electromagnet thereon but not touching it and adapted to reciprocate in the direction of the axis of rotation without retardation of the said axle synchronously with the pulsations of the said currents, and means on said balanced rocking lever to actuate a counting-train, substantially as described.

617,737. MEANS FOR BONDING RAILWAY-RAILS; F. Hachmann, of Milwaukee, Wis. App. filed Sept. 14, 1898. A bonding device for bonding

together railway-rails, consisting of an integral metal bar and legs thereon, one at each extremity of the bar projecting in the same direction, the legs having laterally-projecting toes on corresponding sides of the legs.

617,765. FUSE-PLUG; L. C. Orrell, of Chicago, Ill. App. filed September 25, 1897. The combination with two clamping parts in a fuse-plug for electrical circuits, one of which is provided outside of its coacting surface with a raised lip or projection, of a wire which passes transversely over said lip in binding contact therewith, and is clamped at its end between coacting surfaces of said parts.

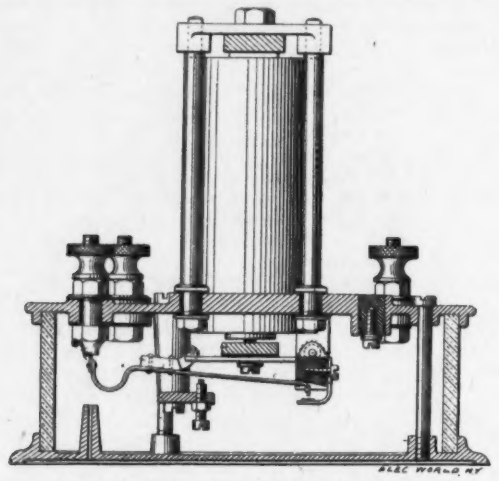
617,793. REGULATOR FOR CONSTANT-CURRENT DYNAMOS; J. J. Wood, of Fort Wayne, Ind. App. filed July 8, 1898. In a dynamo regulator, an operating lever having an adjustable arm combined with oppositely acting set-screws for adjusting and setting said arm.

617,804. ANCHOR FOR OVERHEAD WIRES; J. G. Buehler, of New York, N. Y. App. filed Sept. 1, 1898. In a securing device for overhead electric wires, the combination of the double pull-over, the line-ear connected thereto, the side-piece connected to said line-ear, and means on said pull-over for attaching the stay-wires.

617,837. ELECTRIC RAILWAY SYSTEM; E. B. Walter Reichel, of Berlin, Germany. App. filed Oct. 3, 1898. In an electric railway system, the combination with a plurality of motor cars in a single train, of motor-controllers upon said cars, an indicator upon one of the motor-cars, and means governed by the motor-controller upon another car for operating said indicator, substantially as described.

617,838. ELECTROMAGNET; M. Schiesmann, of Dresden, Germany. App. filed Dec. 31, 1897. A multipolar electromagnet, comprising a conductive core, conductive spools carrying the wire coils, threaded on said core, said coils wound and interconnected to form a multipolar electromagnet with alternating positive and negative poles, the flanges of said spools constructed with a wide base at right angles to the longitudinal axis of the electromagnet.

617,839. CONNECTION-COUNTING MECHANISM FOR TELEPHONE-LINES; C. E. Scribner, of Chicago, Ill. App. filed March 15, 1897. The combination with a telephone-line and a connection counter associated therewith, of a line-jack and an answering-jack connected with the line, a



No. 617,853.—Electric Signaling.

connecting-plug for use with the spring-jacks, and circuit connections of the said connection-counter with the answering-jack only adapted to cooperate with circuits terminating in the said plug to render the connection-counter operative.

617,842. METHOD OF AND MEANS FOR DERIVING POLYPHASE CURRENTS; H. A. Wagner, of St. Louis, Mo. App. filed Nov. 13, 1896. In a system of electrical distribution, a supply-circuit of alternating currents, circuits derived therefrom having one of the ends of each joined together and the other ends thereof each connected to a different point on said supply-circuit, and a circuit containing suitable inductive resistance connecting the common junction so formed to the supply-circuit at a point differing in potential from the said points of connection of said derived circuits.

617,853. ELECTRIC SIGNALING; J. P. Coleman, of Edgewood Park, Pa. App. filed Dec. 2, 1897. In a relay, the combination of a magnet, an armature-lever, a contact-plate pivotally supported by the lever, means for preventing a movement of the plate independent of the lever during the normal operation of the relay and front and rear contact-point.

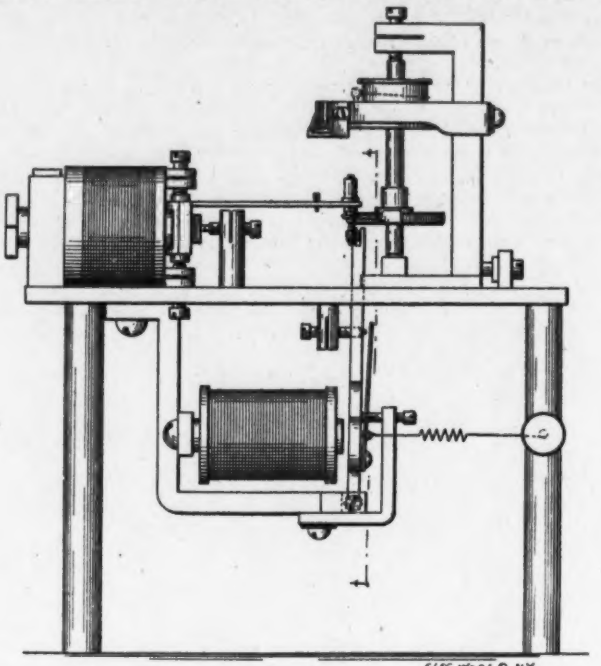
617,854. RELAY; J. P. Coleman, of Edgewood Park, Pa. App. filed Jan. 20, 1898. The combination of a magnet, an armature, pivotal supports for the armature so arranged as to permit of movements of the armature in planes at an angle to each other and contact-plates pivotally mounted on the armature.

617,858. MAGNETO-CIRCUIT CLOSER; J. E. Fuller, of New York, N. Y. App. filed Nov. 10, 1898. The combination with the field-magnet, the armature and its coil, of a switch having magnetic material that is acted upon by the change of magnetic strength, and circuit-closing stops at opposite sides of the switch with which the switch is brought into contact in one direction by the action of a spring and in the other direction by the action of the magnetism.

617,890. TELAUTOGRAPH; G. S. Tiffany, of Highland Park, Ill. App. filed May 29, 1896. The method of transmitting telautographic messages, which consists in transmuting the movements of the transmitting-pen into impulses of successively like polarity, transmuting these impulses by induction into pulsations of successively opposite polarity, and causing the receiving pen to move a step under the influence of each of the latter pulsations, substantially as described.

617,892. TELAUTOGRAPH; G. S. Tiffany, of Highland Park, Ill. App. filed Aug. 21, 1897. The combination of the escape-wheel with the two-legged pivoted pawl, the two legs occupying such a relation to each other that when either acts as a propeller the other acts as a stop.

617,901. APPARATUS FOR PRODUCING ELECTRIC CURRENTS; M. C. Massie, of Washington, D. C. App. filed Oct. 11, 1898. The combination with a Wheatstone bridge, of means for repeatedly and alternately balanc-



No. 617,892.—Telautograph.

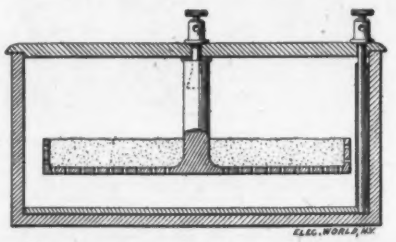
ing and unbalancing the resistances of the branches of said bridge, and means for energizing the branches, whereby a current is produced in the bridge-conductor.

617,908. GALVANIC BATTERY; C. T. Richmond, of Cleveland, Ohio. App. filed July 18, 1898. In a galvanic battery, the combination of a containing vessel with a carbon plate adapted to serve as a cover for said vessel and having two threaded bosses on its under side, and a hole between said bosses, two carbon electrodes which are screwed onto said bosses, and a zinc electrode which lies between said carbon electrodes, and a stem which passes out through the hole in the cover-plate between said bosses, substantially as described.

617,938. ELECTRICAL-ALARM MATTING; A. D. Risley, of Richfield Springs, N. Y. App. filed Jan. 27, 1898. The elastic non-conductor provided with orifices and conducting-strips and arranged respectively above and below said orifices and forming the insulated terminals of an electrical-alarm circuit, and a loose conductor caged within said orifices.

617,958. ELECTRICAL APPARATUS FOR FREEING, LIGHTING OR EXTINGUISHING GAS-BURNERS AT A DISTANCE; P. L. Guyenot, of Aix-les-Bains, France. App. filed July 30, 1898. In an electrically operated apparatus for freeing, lighting and extinguishing gas-burners by means of a ball valve, the combination of a ball-valve having a plurality of valve-seats, with an electromagnet adapted to operate the valve and a permanent magnet for determining which valve seat is to remain open, substantially as described.

618,042. GALVANIC BATTERY; J. D. Darling, of Philadelphia, Pa. App. filed Oct. 16, 1897. The combination with an enclosing vessel, of an element in the form of a horizontal conducting-plate having a surface of peroxide of



No. 618,042 —Galvanic Battery.

lead applied thereto, and an element of amalgamated zinc disposed in the form of a horizontal plate of comparatively small vertical height and fitting closely against the interior sides of the enclosing vessel, said elements being arranged with their proximate surfaces at a substantially uniform distance throughout.

618,043. ZINC ELECTRODE; J. D. Darling, of Philadelphia, Pa. App. filed August 17, 1898. The combination of a cup-shaped zinc electrode, with a mass of solid zinc amalgam contained therein, substantially as described.